HRS DOCUMENTATION RECORD--REVIEW COVER SHEET

Name of Site: Lower Duwamish Waterway

Contact Persons:

Site Investigation: Roy F. Weston, Inc.

Documentation Record: Tara Karamas, Ecology and Environment, Inc., Seattle
Mark Ader, U.S. Environmental Protection Agency, Seattle

Pathways, Components, or Threats Not Scored

The ground water migration pathway, groundwater-to-surface water component of the surface water migration pathway, soil exposure pathway, and air migration pathway were not scored as part of this Hazard Ranking System (HRS) evaluation. These pathways/components were not included because a release to these media does not significantly affect the overall site score and because the overland flow/flood component of the surface water migration pathway produces an overall site score well above the minimum required for the site to qualify for inclusion on the National Priorities List. These pathways are of concern to the U.S. Environmental Protection Agency (EPA) and may be evaluated during future investigations.

Site Summary

The Duwamish River originates at the confluence of the Green and Black Rivers near Tukwila, Washington, then flows northwest for approximately 21 kilometers, dividing at the southern end of Harbor Island prior to discharging into Elliot Bay. The segment of river from river kilometer (RK) 2.5 at the southern end of Harbor Island to RK 10.8 located approximately 0.8 kilometers upstream of the upper turning basin (Turning Basin #3) contains contaminated sediments. A portion of this river segment is maintained by the U.S. Army Corps of Engineers (USACE) as a federal navigation channel (i.e., the reach downchannel of Turning Basin #3). This portion is typically referred to as the Duwamish Waterway. The shorelines along the majority of the Duwamish Waterway have been developed for industrial and commercial operations, as the waterway serves as a major shipping route for containerized and bulk cargo. Much of the upland areas adjacent to the project area are heavily industrialized, and marine traffic within the Duwamish Waterway is considered to be intensive. In addition, this reach of the river is the receiving body for discharges from numerous storm drains, combined sewer overflows, and outfalls.

HRS DOCUMENTATION RECORD

Name of Site: Lower Duwamish Waterway

EPA Region 10 Date Prepared: October 4, 2000

CERCLIS No.: WA0002329803

Street Address of Site: Not applicable, the source is contaminated sediments

County and State: King, Washington

General Location in the State: Northwest

Topographic Map: Seattle South, Washington, 7.5 x 15 Minute Series, 1983

LATITUDE AND LONGITUDE OF SITE			
Sample Number	**River Kilometer**	**Latitude**	**Longitude**
To NOAA Sample EIT02-04	10.8	47° 30' 36.29" North	122° 17' 34.26" West

Scores

Groundwater Pathway	0.00
Surface Water Pathway	100.00
Soil Exposure Pathway	0.00
Air Pathway	0.00
HRS SITE SCORE	50.00

SURFACE WATER OVERLAND FLOW/FLOOD MIGRATION COMPONENT SCORESHEET

SURFACE WATER OVERLAND FLOW/FLOOD MIGRATION COMPONENT Factor Categories and Factors DRINKING WATER THREAT	Maximum Value	Assigned Value
Likelihood of Release		
1. Observed Release	550	550
2. Potential to Release by Overland Flow:		
2a. Containment	10	
2b. Runoff	25	
2c. Distance to Surface Water	25	
2d. Potential to Release by Overland Flow (lines 2a[2b + 2c])	500	
3. Potential to Release by Flood:		
3a. Containment (Flood)	10	
3b. Flood Frequency	50	
3c. Potential to Release by Flood (lines 3a x 3b)	500	
4. Potential to Release (lines 2d + 3c, subject to a maximum of 500)	500	
5. Likelihood of Release (higher of lines 1 and 4)	550	550
Waste Characteristics		
6. Toxicity/Persistence	*	10,000
7. Hazardous Waste Quantity	*	100
8. Waste Characteristics	100	32
Targets		
9. Nearest Intake	50	0
10. Population		
10a. Level I Concentrations	**	0
10b. Level II Concentrations	**	0
10c. Potential Contamination	**	0
10d. Population (lines 10a+10b+10c)	**	0
11. Resources	5	0
12. Targets (lines 9 + 10d + 11)	**	0
13. DRINKING WATER THREAT SCORE	100	0

* Maximum value applies to waste characteristics category

** Maximum value not applicable

SURFACE WATER OVERLAND FLOW/FLOOD MIGRATION COMPONENT SCORESHEET

SURFACE WATER OVERLAND FLOW/FLOOD MIGRATION COMPONENT Factor Categories and Factors HUMAN FOOD CHAIN THREAT	Maximum Value	Assigned Value
Likelihood of Release		
14. Likelihood of Release (same as line 5)	550	550
Waste Characteristics		
15. Toxicity/Persistence/Bioaccumulation	*	5×10^8
16. Hazardous Waste Quantity	*	100
17. Waste Characteristics	1000	320
Targets		
18. Food Chain Individual	50	45
19. Population	**	
19a. Level I Concentrations	**	0
19b. Level II Concentrations	**	0.03
19c. Potential Contamination	**	0.000003
19d. Population (lines 19a+19b+19c)	**	45.030003
20. Targets (lines 18 + 19d)	**	45.030003
21. HUMAN FOOD CHAIN THREAT SCORE	100	96.06

* Maximum value applies to waste characteristics category
** Maximum value not applicable

SURFACE WATER OVERLAND FLOW/FLOOD MIGRATION COMPONENT SCORESHEET

SURFACE WATER OVERLAND FLOW/FLOOD MIGRATION COMPONENT Factor Categories and Factors ENVIRONMENTAL THREAT	Maximum Value	Assigned Value
Likelihood of Release		
22. Likelihood of Release (same as line 5)	550	550
Waste Characteristics		
23. Ecosystem Toxicity/Persistence/Bioaccumulation	*	5×10^8
24. Hazardous Waste Quantity	*	100
25. Waste Characteristics	1000	320
Targets		
26. Sensitive Environments		
26a. Level I Concentrations	**	0
26b. Level II Concentrations	**	225
26c. Potential Contamination	**	0.0075
26d. Sensitive Environments (lines 26a+26b+26c)	**	225.0075
27. Targets	**	225.0075
28. ENVIRONMENTAL THREAT SCORE	60	60
29. WATERSHED SCORE	100	100
30. SURFACE WATER OVERLAND FLOW/FLOOD COMPONENT SCORE	100	100

* Maximum value applies to waste characteristics category

** Maximum value not applicable

WORKSHEET FOR COMPUTING HRS SITE SCORE

		S	S^2
1.	Groundwater Migration Pathway Score (S_{GW})	Not Scored	0
2a.	Surface Water Overland Flow/Flood Component (from HRS Table 4-1, line 30)	100.00	
2b.	Groundwater to Surface Water Migration Component (from HRS Table 4-25, line 28)	Not Scored	
2c.	Surface Water Migration Pathway Score (S_{SW}) Enter the larger of lines 2a and 2b as the pathway score	100.00	10,000.00
3	Soil Exposure Pathway Score (S_s)	Not Scored	0
4.	Air Migration Pathway Score (S_a) (from HRS Table 6-1, line 12)	Not Scored	0
5.	Total of $S_{GW}^2 + S_{SW}^2 + S_s^2 + S_a^2$		10,000.00
6.	**HRS Site Score.** Divide the value on line 5 by 4 and take the square root.	50.00	

REFERENCES

Reference Number	Description of the Reference
1.	U.S. Environmental Protection Agency, December 14, 1990. Hazard Ranking System, Final Rule, 40 CFR Part 300, Appendix A, 55 FR 51532.
2.	U.S. Environmental Protection Agency, June 1996. Superfund Chemical Data Matrix.
3.	U.S. Geological Survey, 7.5 x 15 minute series, Topographic Map, Seattle South, Washington 1983.
4.	Roy F. Weston, April 1999, Site Inspection Report, Lower Duwamish River (RK 2.5 to 11.5), Seattle, Washington, Volumes 1 (Report and Appendices) and Volume 2 (Map Folio), 1,129 pages.
5.	Roy F. Weston, July 1998, Site Inspection, Lower Duwamish River (RK 2.5 to 11.5), Seattle, Washington, Sampling and Analytical Plan, 75 pages.
6.	Roy F. Weston, November and December 1998, Site Inspection, Lower Duwamish River (RK 2.5 to 11.5), Seattle, Washington, Quality Assurance Memoranda and Laboratory Data Sheets, 3,711 pages.
7.	Exponent, March 1998, Duwamish Waterway, Phase I Site Characterization Report, prepared for The Boeing Company, 147 pages.
8.	National Oceanic and Atmospheric Administration, December 10, 1998, Duwamish Waterway Sediment Characterization Study Report, 102 pages.
9.	St. Amant, Glen, Muckleshoot Indian Tribe, January 11, 2000, telephone conversation with Tara Karamas, Ecology and Environment, Inc., regarding the location of fisheries in the Duwamish River, 1 page.
10.	Reference reserved.
11.	National Oceanic and Atmospheric Administration, March 19, 1998, letter from Mr. David Kennedy to Mr. Chuck Clarke, U.S. Environmental Protection Agency, requesting a preliminary assessment of the lower Duwamish River, King County, Washington, 2 pages.
12.	Washington State Department of Fish and Wildlife, August 1, 2000, Habitats and Species Information for the Seattle South Quadrangle, 18 pages.
13.	Washington Department of Fish and Wildlife, 1994, Washington State Sport Catch Report for Foodfish, pages 1, 2, 3, 4, 26, and 54.
14.	State of Washington, Department of Fish and Wildlife, 1994, Fisheries Statistical Report, pages 75 through 80.
15.	Roy F. Weston, August and September 1998, Site Inspection, Lower Duwamish River (RK 2.5 to 11.5), Seattle, Washington, Chain-of-Custody forms, 117 pages.
16.	National Oceanic and Atmospheric Administration, December 10, 1998, Duwamish Waterway Sediment Characterization Study, Chain-of-Custody forms, 41 pages.

17. Parametrix, Inc., July 17, 1998, Combined Sewer Overflow Water Quality Assessment for the Duwamish River and Elliott Bay, Volume 1; Summary Report, prepared for King County, 144 pages.

18. Woodke, Mark, Ecology and Environment, Inc., July 28, 2000, telephone conversation with Mr. Kenneth Davis, Applied Marine Sciences, regarding their grain size method, 1 page.

19. Ecology and Environment, Inc., July 2000, Percent Total Fines Calculations from the National Oceanic and Atmospheric Administration, Duwamish Waterway Sediment Characterization, Fall 1997, 11 pages.

20. U.S. Fish and Wildlife Service, 1987, National Wetland Inventory Map, Seattle South, Washington.

21. Purser Jr., Robert, Suquamish Tribe, July 20, 2000, letter to Mark Ader, U.S. Environmental Protection Agency, regarding usual and accustomed hunting and fishing areas, 4 pages.

22. Roy F. Weston, Data Delivery Notes from the data set containing Duwamish SI analytical results as captured in April 1999, 2 pages.

23. U.S. Environmental Protection Agency, November 1996. Using Qualified Data to Document an Observed Release and Observed Contamination, OSWER 9285.7-14FS, 18 pages.

24. Woodke, Mark, Ecology and Environment, Inc., August 4, 2000, memorandum to Linda Foster, Ecology and Environment, Inc., regarding the assignment of biases to qualified data, 8 pages.

25. National Oceanic and Atmospheric Administration, December 10, 1998, Duwamish Waterway Sediment Characterization Study Report Sample Location Map as generated by Ecology and Environment, Inc., 1 page.

26. National Oceanic and Atmospheric Administration, March 16, 1999, Announcement of 8 Evolutionarily Significant Units (ESU) as Threatened and 1 ESU as Endangered, as accessed via the Internet on August 9, 2000 at www.nwr.noaa.gov/1salmon/salmesa/maps, 2 pages.

27. Gregory Baker, National Oceanic and Atmospheric Administration, August 11, 2000, transmittal letter to Mark Ader, U.S. Environmental Protection Agency, 278 pages.

28. Gregory Baker, National Oceanic and Atmospheric Administration, August 8, 2000, letter to Mark Ader, U.S. Environmental Protection Agency, regarding Natural Resources as Risk in the Duwamish River, 2 pages.

29. Woodke, Mark, Ecology and Environment, Inc., September 13, 2000, letter to Linda Foster, Ecology and Environment, Inc., regarding Sample Quantitation Limits for sediment samples collected during the 1997 National Oceanic and Atmospheric Administration Sediment Characterization Study of the Duwamish River.

30. Bernadita Anulacion, National Oceanic and Atmospheric Administration, Northwest Fisheries Service Center, August 31, 2000, transmittal letter to Linda Foster, Ecology and Environment, Inc., 659 pages.

31. Agency of Toxic Substances and Disease Registry, September 1997, ToxFQAs, Polychlorinated Biphenyls (PCBs), 4 pages.

2.2 SOURCE CHARACTERIZATION

Number of the source: 1

Name and description of the source: Contaminated sediments (other)

Source 1 consists of contaminated sediments in the Duwamish River watershed. A single source of hazardous substances for the contaminated sediments has not been identified. Much of the upland areas adjacent to this source are heavily industrialized, and marine traffic within the Duwamish Waterway is considered to be intensive (Ref. 4, p. 8). Historical or current commercial and industrial operations include cargo handling and storage; marine construction; boat manufacturing; maintenance and repair; marina operations; concrete and other stone material manufacturing and distribution; paper and metals fabrication; food processing; and airplane parts manufacturing (Ref. 4, p. 8). In addition, this reach of the river is the receiving body for discharges from numerous municipal storm drain dicharges (SDs) and combined sewer overflow discharges (CSOs), as well as multiple privately held outfalls and drains (Ref. 4, p. 8).

Numerous past investigations within the Duwamish Waterway have been conducted with varying scopes. Some of the historical studies focused on specific properties, while the remaining studies were riverwide (Ref. 4, p. 8). These past sediment studies have indicated that polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), metals, miscellaneous organic compounds, pesticides, and organotins are present in the river sediments (Ref. 4, p. 8). More recent sediment studies have substantiated the historical data and documented the presence of contaminated sediments (see Hazardous Substances section below). These contaminants may have entered the river via several transport pathways or mechanisms, including spillage during product shipping and handling, direct disposal or discharge, contaminated groundwater discharge, surface water runoff, storm water discharge, or contaminated soil erosion (Ref. 4, p. 8).

Location of the source, with reference to the site:

The contaminated sediments begin at the most upstream contaminated sediment sample location located near the upper turning basin (i.e., Turning Basin #3) of the Duwamish River at RK 10.8 and extend downstream to the southern tip of Harbor Island at RK 2.5 (Ref. 3).

Containment

Release to Surface Water via Overland Migration and/or Flood: The source is contaminated sediments, which by definition have no containment. Since the sediments may be mobilized and transported within the watershed, there is evidence of hazardous substance migration. A surface water containment factor value of 10 is assigned (Ref. 1, Table 4-2).

Containment Value: 10

2.2.2 Hazardous Substances

Lower Duwamish River (RK 2.5 to RK 11.5) Site Inspection (Weston, 1999) (Ref. 4):

Consultants for the EPA conducted Lower Duwamish River SI field work in August and September 1998 (Ref. 4, pp. 42 through 364). Sampling activities included the collection of 312 surface (0 to 10 centimeter) sediment samples, 35 subsurface (0 to 0.6 meter or 0 to 60 centimeters) sediment samples, and 16 sediment porewater samples from the Duwamish River between RK 2.5 and RK 11.5, although contaminated sediments in the upper portion of this reach (i.e., between approximately RK 10.3 and 11.5 were not documented (Ref. 4, pp. 12 and 13). Only the surface sediment samples will be used in the documentation record to document observed releases that define the area of the contaminated sediment source, although it is expected that subsurface sediment samples and porewater samples also may document additional observed releases. All surface sediment samples were collected from 5 to 17 centimeters with a decontaminated stainless-steel van Veen grab sampler (Ref. 4, pp. 13 and 15; Ref. 5, pp. 24 and 25). Up to 11 grabs were required at each station to retrieve sufficient sediment volume for the required analytical suite (Ref. 4, p. 13). Samples were homogenized in stainless steel containers and then placed in pre-cleaned sample jars (Ref. 4, p. 13). All sample containers were stored on ice in coolers maintained under chain-of-custody prior to and during shipment (Ref. 4, pp. 13 and 15; Ref. 5, p. 23; Ref. 15).

Surface sediment samples were analyzed for a variety of analytical suites in varying combinations dependent on the suspected contaminants at each individual location. All samples were analyzed for target analyte list metals (EPA Method series 6000/7000), Base/Neutral/Acid extractable organic compounds (EPA Method 8270), PCBs (EPA Method 8082), total organic carbon (TOC) (EPA Method 9060), and grain size (ASTM D-442-63) (Ref. 4, p. 14; Ref. 5, pp. 56 through 59). Selected samples also were analyzed for pesticides (EPA Method 8081), organotins (Puget Sound Estuary Program protocols), and dioxin/furans (Ref. 4, p. 14; Ref. 5, pp. 56 through 59).

Background samples were selected for determining observed release concentrations by considering contaminant variances expected as a function of grain size (i.e., some contaminants have affinities for small particles and will tend to be more concentrated in samples with a high percentage of fines). In selecting background concentrations, first all sediment samples were divided into four grain size classifications (0 – 25%, 25 – 50%, 50 – 75%, and 75 to 100%) based on the percent of fines present (i.e., particles smaller than sands), then three or more relatively upriver samples were selected from each grain size classification to represent background conditions. Five sample points were preselected as background for the SI from an upriver area, however, all of these samples (i.e., SD-DR297 through SD-DR301) fell into the same grain size classification (Ref. 5, pp. 15 and 37; Ref. 4, p. 898).

Generally, results by analyte for the selected background samples in each grain size classification were averaged for use in determined observed releases, except: when the analyte was detected in only one sample, this detected value was used; when the analyte was detected in two or more samples, but not all samples, the detected values were averaged for use; and when all results were undetected, the highest quantitation limit was used. To calculate the average background concentration, all of the selected background concentrations were added and then the sum was divided by the number of background samples used for that analyte and grain size classification. Table 1 below provides sample results for all background samples used and provides the background value used for determining observed releases in later tables.

Selected analytes meeting observed release criteria are presented in the following tables (Table 2 through Table 5) (Ref. 1, Section 2.3). Not all analytes meeting observed release criteria are presented. Blank cells in the table are for sample results that did not document an observed release. Total PCB results in these tables were calculated by Roy F. Weston (Ref. 22). The following data qualifiers apply to the these tables (Ref. 4, p. 379; Ref. 23; Ref. 24):

AC - Adjusted concentration as per EPA Guidance Document “Using Qualified Data to Document an Observed Release and Observed Contamination” (Ref. 23).

H - EPA data qualifier indicating a high bias (Ref. 4, p. 379; Ref. 24).

J - The analyte was positively identified and detected; however, the concentration is an estimated value because the result is less than the quantitation limit or quality control criteria were not met (Ref. 4, p. 379).

K - Unknown bias (Ref. 24).

L - EPA data qualifier indicating a low bias (Ref. 4, p. 379; Ref. 24).

Q - EPA data qualifier indicating that the result is estimated because the concentration is below the Contract Required Quantitation Limit (CRQLs) (Ref. 4, p. 379).

T - When present in data qualifier, indicates value was assumed from other constituents by software. Result was not present in original laboratory reports (Ref. 4, p. 379; Ref. 22; Ref. 24).

U - The analyte was not detected at the given concentration limit (Ref. 4, p. 379).

Table 1

BACKGROUND COMPUTATIONS

	0 to 25%					
SAMPLE NO.	SD-DR297-0000	SD-DR298-0000	SD-DR299-0000	SD-DR300-0000	SD-DR301-0000	
EPA SAMPLE NO.	98384021	98384022	98384024	98384025	98384023	BACKGROUND
PERCENT TOTAL FINES	0.47	1.26	2.91	1.44	2.28	VALUE
Pages in Reference 6	750, 1846, 1847, 2729, 3067, 3274	751, 1849, 1850, 2730, 3067, 3275	753, 1855, 1856, 2732, 3067, 3277	754, 1858, 1859, 2733, 3067, 3278	752, 1852, 1853, 2731, 3067, 3276	NA
BNA (ug/kg)						
Anthracene	20 U	20 U	20 U	20 U	20 U	20 U
Benz(a)anthracene	20 U	20 U	20 U	20 U	20 U	20 U
Benzo(a)pyrene	20 U	20 U	20 U	20 U	20 U	20 U
Benzo(b)fluoranthene	20 U	20 U	20 U	20 U	20 U	20 U
Benzo(k)fluoranthene	20 U	20 U	20 U	20 U	20 U	20 U
Bis(2-ethylhexyl) Phthalate	20 U	20 U	20 U	20 U	20 U	20 U
Chrysene	20 U	20 U	20 U	20 U	20 U	20 U
Dibenz(a,h)anthracene	20 U	20 U	20 U	20 U	20 U	20 U
Fluoranthene	20 U	20 U	20 U	20 U	20 U	20 U
Fluorene	20 U	20 U	20 U	20 U	20 U	20 U
Indeno(1,2,3-cd)pyrene	20 U	20 U	20 U	20 U	20 U	20 U
Phenanthrene	20 U	20 U	20 U	20 U	20 U	20 U
Pyrene	20 U	20 U	20 U	20 U	20 U	20 U
INORGANIC (mg/kg)						
Arsenic	4.0	5.1	4.2	4.1	4.4	4.36
Cadmium	0.04 UJH	0.05 UJH	0.04 UJH	0.2 UJH	0.2 U	0.2 UJH
Chromium	10	11	9	10	8	9.6
Copper	10	11	12	12	11	11.2
Mercury	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Nickel	10.6	10.1	11.0	10.7	9.3	10.34
ORGANOTN (ug/kg)						
Di-n-butyltin	1 U	1 U	1 U	1 U	1 U	1 U
n-Butyltin	1 UJL	1 UJL	1 UJL	1 UJL	1 UJL	1 UJL (10 U AC)
Tetra-n-butyltin	3 U	3 U	3 U	3 U	3 U	3 U
Tri-n-butyltin	1 U	1 U	1 U	1 U	1 U	1 U
PEST/PCB (ug/kg)						
Total PCB	40 UT	40 UT	40 UT	40 UT	40 UT	40 UT

Table 1

BACKGROUND COMPUTATIONS

	25% to 50%				
SAMPLE NO.	SD-DR273-0000	SD-DR274-0000	SD-DR275-0000	SD-DR293-0000	
EPA SAMPLE NO.	98354035	98384018	98384017	98384006	BACKGROUND
PERCENT TOTAL FINES	43.46	31.75	37.55	43.75	VALUE
Pages in Reference 6	1037, 2264, 2265, 2903, 3053, 3383	747, 1837, 1838, 2726, 3067	746, 1834, 1835, 2725, 3067	686, 1950, 1951, 2773, 3066	NA
BNA (ug/kg)					
Anthracene	20	90	20	30	40
Benz(a)anthracene	130	370	100	140	185
Benzo(a)pyrene	160	440	130	180	227.5
Benzo(b)fluoranthene	170	400	110	190	217.5
Benzo(k)fluoranthene	180	420	130	180	227.5
Bis(2-ethylhexyl) Phthalate	120	150	110	330 UJH	126.67
Chrysene	190	490	140	210	257.5
Dibenz(a,h)anthracene	30	70	20 U	30	43.33
Fluoranthene	390	1100	330	430	562.5
Fluorene	20 U	30	20 U	20 U	30
Indeno(1,2,3-cd)pyrene	120	320	110	140	172.5
Phenanthrene	180	550	170	210	277.5
Pyrene	300	850	220	350	430
INORGANIC (mg/kg)					
Arsenic	10.7	6.1	7.4	7.0	7.8
Cadmium	0.18	0.2 UJH	0.11 UJH	0.1 JQ (0.2 U)	0.18
Chromium	20	20	18	22	20
Copper	24	22	21	26	23.25
Mercury	0.12	0.06	0.04 JQ (0.05 U)	0.21	0.13
Nickel	15.0	15.2	14.1	17.6	15.475
ORGANOTN (ug/kg)					
Di-n-butyltin	2 JL				2 JL (20 AC)
n-Butyltin	2 JL				2 JL (20 AC)
Tetra-n-butyltin	1 UJL				1 UJL (10 U AC)
Tri-n-butyltin	4 JL				4 JL (40 AC)
PEST/PCB (ug/kg)					
Total PCB	45 T	40 UT	40 UT	40 UT	45 T

Table 1

BACKGROUND COMPUTATIONS

	50% TO 75%				75% TO 100%			
SAMPLE NO.	SD-DR268-0000	SD-DR272-0000	SD-DR291-0000		SD-DR281-0000	SD-DR290-0000	SD-DR250-0000	
EPA SAMPLE NO.	98354041	98354034	98354046	BACKGROUND	98354051	98354047	99354050	BACKGROUND
PERCENT TOTAL FINES	54.86	55.90	58.78	VALUE	78.63 J	77.60 J	76.69 J	VALUE
Pages in Reference 6	535, 1870, 1871, 2741, 3053	1036, 2261, 2262, 2902, 3053	540, 1885, 1886, 2746, 3053, 3246	NA	545, 1900, 1901, 2751, 3053	541, 1888, 1889, 2747, 3053	544, 1897, 1898, 2750, 3053	NA
BNA (ug/kg)								
Anthracene	50	20 U	30	40	20	30	20 U	25
Benz(a)anthracene	200	80	140	140	140	130	40	103.33
Benzo(a)pyrene	120	110	140	123.33	130	140	40	103.33
Benzo(b)fluoranthene	180	110	210	166.67	180	220	50	150
Benzo(k)fluoranthene	210	120	190	173.33	190	180	50	140
Bis(2-ethylhexyl) Phthalate	150 UJH	80	490	285	530	500	110 UJH	515
Chrysene	400	130	220	250	230	220	60	170
Dibenz(a,h)anthracene	20	20 U	20	20	20	20 U	20 U	20
Fluoranthene	1700	280	380	786.67	440	410	100	316.67
Fluorene	20	20 U	20	20	20 U	30	20 U	30
Indeno(1,2,3-cd)pyrene	80	80	100	86.67	90	100	40	76.67
Phenanthrene	460	120	180	253.33	160	190	50	133.33
Pyrene	1600	210	410	740	410	420	90	306.67
INORGANIC (mg/kg)								
Arsenic	8.0	10.4	13.5	10.63	15.4	15.0	9	13.13
Cadmium	0.19	0.20	0.34	0.24	0.36	0.40	0.23	0.33
Chromium	24	26	23	24.33	26	28	27	27
Copper	30	29	39	32.67	44	46	34	41.33
Mercury	0.07	0.07	0.12	0.09	0.12	0.13	0.12	0.12
Nickel	18.4 JL (23.74 AC)	15.1	17.2 JL (22.19 AC)	21	18.2 JL (23.48 AC)	21.8 JL (28.12 AC)	21.6 JL 27.86 AC)	28
ORGANOTN (ug/kg)								
Di-n-butyltin			1 JL	1 JL (10 AC)				
n-Butyltin			12 UJL	12 UJL (120 U AC)				
Tetra-n-butyltin			1 UJL	1 UJL (10 U AC)				
Tri-n-butyltin			5 JL	5 JL (50 AC)				
PEST/PCB (ug/kg)								
Total PCB	34 T	52 T	127 T	71 T	193 T	170 T	40 UT	181.5 T

Table 2

SEDIMENT SAMPLE OBSERVED RELEASE
0% TO 25% TOTAL FINES

SAMPLE NO. EPA SAMPLE NO. PERCENT TOTAL FINES	METHOD REPORTING LIMITS [A]	BACKGROUND VALUE	SD-DR036-0000 98334008 7.89	SD-DR076-0000 98354013 3.22	SD-DR091-0000 98364013 21.92	SD-DR092-0000 98354085 22.10	SD-DR099-0000 98344076 21.05	SD-DR100-0000 98344077 20.53
Page Number in Ref. 6			1363, 2520, 3028	2191, 3052	1205, 2378, 2379, 3060	1101, 2342, 2343, 3055	1651, 1652, 3078	1654, 1655, 3078
BNA (ug/kg)								
Anthracene	20	20 U	20		130	50	70	120
Benz(a)anthracene	20	20 U	90		300	130	140	200
Benzo(a)pyrene	20	20 U	90		190	110	110	170
Benzo(b)fluoranthene	20	20 U	90		260	130	160	230
Benzo(k)fluoranthene	20	20 U	80		210	130	100	200
Bis(2-ethylhexyl) Phthalate	20	20 U		6100 (0.2)	110	110		
Chrysene	20	20 U	130		380	180	180	360
Dibenz(a,h)anthracene	20	20 U	20		40			30
Fluoranthene	20	20 U	180		1100	400	280	360
Fluorene	20	20 U			90	50	30	30
Indeno(1,2,3-cd)pyrene	20	20 U	70		120	60	60	130
Phenanthrene	20	20 U	130		560	230	110	110
Pyrene	20	20 U	280		820	360	230	310
INORGANIC (mg/kg)								
Arsenic	0.5	4.4						
Chromium	2	9.6						
Copper	2	11.2						
Nickel	0.2	10.3	35.8					
PEST/PCB (ug/kg)								
Total PCB	20	40 UT			45 T	64 T		

Notes:

A = Method reporting limits are uniform for all samples evaluated unless another value is listed with the sample result. This values will appear in parenthesis along with the sample result.

Table 2

SEDIMENT SAMPLE OBSERVED RELEASE
0% TO 25% TOTAL FINES

SAMPLE NO. EPA SAMPLE NO. PERCENT TOTAL FINES	METHOD REPORTING LIMITS [A]	BACKGROUND VALUE	SD-DR124-0000 98384010 24.18	SD-DR131-0000-CC 98334038 20.05	SD-DR142-0000 98344083 6.02	SD-DR143-0000 98364020 16.12	SD-DR173-0000 98344049 24.67	SD-DR209-0000 98354071 12.88
Page Number in Ref. 6			739, 1811, 1812, 2718, 3067	310, 1556, 1557, 2652, 3034	1675, 1676, 3078	2399, 2400, 3060	655, 1733, 1734, 3044	1095, 2322, 3054
BNA (ug/kg)								
Anthracene	20	20 U	120	110	340	120	40	
Benz(a)anthracene	20	20 U	480	280	610	300	160	30
Benzo(a)pyrene	20	20 U	770	240	590	310	170	40
Benzo(b)fluoranthene	20	20 U	1000	330	480	260	190	40
Benzo(k)fluoranthene	20	20 U	740	290	530	330	170	50
Bis(2-ethylhexyl) Phthalate	20	20 U	940	1400			100	160
Chrysene	20	20 U	790	460	620	400	250	60
Dibenz(a,h)anthracene	20	20 U	140	30	90	60	30	
Fluoranthene	20	20 U	1100	820	2200	660	390	
Fluorene	20	20 U	40	90	370	50	20	
Indeno(1,2,3-cd)pyrene	20	20 U	680	150	410	230	100	40
Phenanthrene	20	20 U	430	490	2100	480	160	
Pyrene	20	20 U	1000	710	1300	580	310	
INORGANIC (mg/kg)								
Arsenic	0.5	4.4	31.8					
Chromium	2	9.6	39	31				
Copper	2	11.2	119	44				
Nickel	0.2	10.3						
PEST/PCB (ug/kg)								
Total PCB	20	40 UT	161 T	97 TJL			62 TJL	67 T

Notes:

A = Method reporting limits are uniform for all samples evaluated unless another value is listed with the sample result. This values will appear in parenthesis along with the sample result.

Table 3

SEDIMENT SAMPLES OBSERVED RELEASE
25% TO 50% TOTAL FINES

STATION NO. EPA SAMPLE NO. PERCENT TOTAL FINES	METHOD REPORTING LIMIT [A]	BACKGROUND VALUE	SD-DR031-0000 98334004 35.01	SD-DR010-0000 98384000 25.51	SD-DR022-0000-CC 98344006 39.07	SD-DR047-0000 98384008 48.18	SD-DR058-0000 98364002 30.35	SD-DR067-0000 98344035 25.46
Pages from Reference 6			1345, 1346, 2493, 3028	1932, 1933, 3066	1486, 1487, 3035	688, 1956, 1957, 3066	940, 2086, 3055	1782, 1783, 3044
BNA (ug/kg)								
Anthracene	200	40	350		250	510		290
Benz(a)anthracene	200	185	620		660	1300		
Benzo(a)pyrene	200	227.5				730		
Benzo(b)fluoranthene	200	217.5				850		
Benzo(k)fluoranthene	200	227.5				740		
Bis(2-ethylhexyl) Phthalate	200	126.67	590	760			470	
Chrysene	200	257.5	790		880	1500		
Dibenz(a,h)anthracene	200	43.33						
Fluoranthene	200	562.5			2000	2500		
Fluorene	200	30			110			120
Indeno(1,2,3-cd)pyrene	200	172.5						
Phenanthrene	200	277.5						
Pyrene	200	430			1600	3500		
INORGANICS (mg/kg)								
Arsenic	0.5	7.8						
Cadmium	0.2	0.18						
Chromium	2	20						
Copper	2	23.25	93					
Mercury	0.05	0.13						
ORGANOTINS (ug/kg)								
Tri-n-butyltin		4 JL (40 AC)						
PEST/PCB (ug/kg)								
Total PCB	20	45 T				158 T	1066 TJL	

Notes:
A = Method reporting limits are uniform for all samples evaluated unless another value is listed with the sample result. This values will appear in parenthesis along with the sample result.

Table 3

SEDIMENT SAMPLES OBSERVED RELEASE
25% TO 50% TOTAL FINES

STATION NO. EPA SAMPLE NO. PERCENT TOTAL FINES	METHOD REPORTING LIMIT [A]	BACKGROUND VALUE	SD-DR087-0000 98334023 46.44	SD-DR094-0000 98344073 37.38	SD-DR115-0000 98384003 46.35	SD-DR135-0000 98334046 48.02	SD-DR157-0000 98364021 47.50	SD-DR167-0000 98334045 40.73
Pages from Reference 6			78, 1407, 1408, 2535, 3029, 3156	400, 3045	683, 2770, 3066	318, 2660, 3034	1213, 2402, 2403, 2957, 3060	317, 3034
BNA (ug/kg)								
Anthracene	200	40	270				160	
Benz(a)anthracene	200	185	760					
Benzo(a)pyrene	200	227.5	840					
Benzo(b)fluoranthene	200	217.5	840					
Benzo(k)fluoranthene	200	227.5	700					
Bis(2-ethylhexyl) Phthalate	200	126.67					2300	
Chrysene	200	257.5	800					
Dibenz(a,h)anthracene	200	43.33	210					
Fluoranthene	200	562.5						
Fluorene	200	30	180					
Indeno(1,2,3-cd)pyrene	200	172.5	620					
Phenanthrene	200	277.5	1200					
Pyrene	200	430					1400	
INORGANICS (mg/kg)								
Arsenic	0.5	7.8						
Cadmium	0.2	0.18	0.97 (0.02)			0.56 (0.02)	1.18	
Chromium	2	20						
Copper	2	23.25			83		83	
Mercury	0.05	0.13	0.55				1.6 (0.1)	
ORGANOTINS (ug/kg)								
Tri-n-butyltin		4 JL (40 AC)	180 (10)					
PEST/PCB (ug/kg)								
Total PCB	20	45 T	696 T	393 TJL	142 T	260 TJL	4707 T	139 TJL

Notes:
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Table 3

SEDIMENT SAMPLES OBSERVED RELEASE
25% TO 50% TOTAL FINES

STATION NO. EPA SAMPLE NO. PERCENT TOTAL FINES	METHOD REPORTING LIMIT [A]	BACKGROUND VALUE	SD-DR187-0000 98354070 32.13	SD-DR189-0000 98384005 41.05	SD-DR207-0000 98354076 28.22	SD-DR208-0000 98354074 45.33	SD-DR232-0000 98334060 43.61	SD-DR267-0000 98354042 34.69
Pages from Reference 6			1094, 2318, 2319, 2930, 3054	1947, 1948, 3066	1199, 2357, 2358, 3055	1097, 3055	1626, 1627, 3035	2742, 3053
BNA (ug/kg)								
Anthracene	200	40	800	510	140			
Benz(a)anthracene	200	185	4800	860	920			
Benzo(a)pyrene	200	227.5	3700		1000			
Benzo(b)fluoranthene	200	217.5	3300	1100	1700			
Benzo(k)fluoranthene	200	227.5	4000	840	1200			
Bis(2-ethylhexyl) Phthalate	200	126.67	1500	440				
Chrysene	200	257.5	4100	1600	1800			
Dibenz(a,h)anthracene	200	43.33	950		150			
Fluoranthene	200	562.5	8800	6900	4500			
Fluorene	200	30	530	170	150		110	
Indeno(1,2,3-cd)pyrene	200	172.5	2900					
Phenanthrene	200	277.5	6300	2500	2100			
Pyrene	200	430	10000	3500	4200			
INORGANICS (mg/kg)								
Arsenic	0.5	7.8	48.1					
Cadmium	0.2	0.18	1.4					
Chromium	2	20	64					
Copper	2	23.25						
Mercury	0.05	0.13						0.39
ORGANOTINS (ug/kg)								
Tri-n-butyltin		4 JL (40 AC)						
PEST/PCB (ug/kg)								
Total PCB	20	45 T	246 T		12000 T	388 T		

Notes:
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Table 3

SEDIMENT SAMPLES OBSERVED RELEASE
25% TO 50% TOTAL FINES

STATION NO. EPA SAMPLE NO. PERCENT TOTAL FINES	METHOD REPORTING LIMIT [A]	BACKGROUND VALUE	SD-DR271-0000 98384020 36.42	SD-DR276-0000 98384014 32.84
Pages from Reference 6			749, 3067	1825, 1826, 3067
BNA (ug/kg)				
Anthracene	200	40		140
Benz(a)anthracene	200	185		
Benzo(a)pyrene	200	227.5		
Benzo(b)fluoranthene	200	217.5		
Benzo(k)fluoranthene	200	227.5		
Bis(2-ethylhexyl) Phthalate	200	126.67		
Chrysene	200	257.5		
Dibenz(a,h)anthracene	200	43.33		
Fluoranthene	200	562.5		
Fluorene	200	30		280
Indeno(1,2,3-cd)pyrene	200	172.5		
Phenanthrene	200	277.5		1300
Pyrene	200	430		980
INORGANICS (mg/kg)				
Arsenic	0.5	7.8		
Cadmium	0.2	0.18		
Chromium	2	20		
Copper	2	23.25		
Mercury	0.05	0.13		
ORGANOTINS (ug/kg)				
Tri-n-butyltin		4 JL (40 AC)		
PEST/PCB (ug/kg)				
Total PCB	20	45 T	9400 T (200)	

Notes:
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Table 4

SEDIMENT SAMPLE OBSERVED RELEASE
50% TO 75% PERCENT TOTAL FINES

STATION NO.	METHOD REPORTING LIMITS [A]	BACKGROUND VALUE	SD-DR001-0000	SD-DR006-0000	SD-DR008-0000	SD-DR009-0000	SD-DR028-0000	SD-DR030-0000	SD-DR033-0000
EPA SAMPLE NO.			98364023	98344023	98344025	98344026	98344015	98344018	98334005
PERCENT TOTAL FINES			70.44	72.28	62.56	67.72	74.81	73.19	57.12
Pages in Reference 6			2409, 2959, 3060	503, 1789, 2705, 3039	505, 1795, 2707, 3039, 3237	506, 1798, 2708, 3039	1442, 1443, 3039	150, 1452, 2554, 3039	11, 1348, 1349, 3028
BNA (ug/kg)									
Anthracene	20	40	120	130	220 (200)		180		1500
Benz(a)anthracene	20	140	470	500	1100 (200)	970 (200)	530		1900
Benzo(a)pyrene	20	123.33	410	560	1100 (200)	980 (200)	410		1300
Benzo(b)fluoranthene	20	166.67	580	790	1300 (200)	1100 (200)			1600
Benzo(k)fluoranthene	20	173.33		530	1100 (200)	900 (200)			1100
Bis(2-ethylhexyl) Phthalate	20	285		2700	11000 (200)	11000 (200)		1500	
Chrysene	20	250			1700 (200)	1400 (200)			2400
Dibenz(a,h)anthracene	20	20	60	70	230 (200)	220 (200)	60		190
Fluoranthene	20	786.67			3300 (200)	2900 (200)			6400
Fluorene	20	20					70		570
Indeno(1,2,3-cd)pyrene	20	86.67		360	1000 (200)	880 (200)			770
Phenanthrene	20	253.33			1400 (200)	1400 (200)			2600
Pyrene	20	740			2700 (200)				3300
INORGANIC (mg/kg)									
Arsenic	0.5	10.63	77.2						
Cadmium	0.2	0.24	1.5	0.8 (0.1)	1.8 (0.1)	2.0 (0.1)		2.1	
Chromium	2	24.33							
Copper	2	32.67	153	101	128	130			
Mercury	0.05	0.09			0.29	0.28		0.62	
Nickel	0.2	21							
ORGANOTN (ug/kg)									
Di-n-butyltin		1 JL (10 AC)							
Tri-n-butyltin		5 JL (50 AC)			180 (20)				
PEST/PCB (ug/kg)									
Total PCB	20	71 T		315 TJL	428 TJL	398 TJL		4793 T	225 TJL

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Table 4

SEDIMENT SAMPLE OBSERVED RELEASE
50% TO 75% PERCENT TOTAL FINES

STATION NO.	METHOD REPORTING LIMITS [A]	BACKGROUND VALUE	SD-DR035-0000	SD-DR042-0000	SD-DR043-0000	SD-DR044-0000	SD-DR046-0000	SD-DR057-0000	SD-DR062-0000
EPA SAMPLE NO.			98334006	98334012	98334011	98334013	98334019	98364001	98344009
PERCENT TOTAL FINES			72.04	67.02	56.88	56.31	66.71	62.40	74.66
Pages in Reference 6			12, 2495, 1352, 3028	2524, 3028, 3151	66, 3028	1377, 1378, 3028	3028, 3153	2415, 3055	1495, 1496, 3035
BNA (ug/kg)									
Anthracene	20	40				420		140	360
Benz(a)anthracene	20	140	490			2000		450	620
Benzo(a)pyrene	20	123.33	560			890		490	440
Benzo(b)fluoranthene	20	166.67	770			2000		580	570
Benzo(k)fluoranthene	20	173.33	610			1300			
Bis(2-ethylhexyl) Phthalate	20	285							
Chrysene	20	250	910			4600			
Dibenz(a,h)anthracene	20	20	100			150		90	70
Fluoranthene	20	786.67				23000			
Fluorene	20	20				90			70
Indeno(1,2,3-cd)pyrene	20	86.67	410			520		350	
Phenanthrene	20	253.33	1100			3000			
Pyrene	20	740				16000			
INORGANIC (mg/kg)									
Arsenic	0.5	10.63							
Cadmium	0.2	0.24	0.91 (0.02)						
Chromium	2	24.33							
Copper	2	32.67	182	115					
Mercury	0.05	0.09	0.52						
Nickel	0.2	21							
ORGANOTN (ug/kg)									
Di-n-butyltin	20	1 JL (10 AC)		57 (10)			34 (10)		
Tri-n-butyltin	20	5 JL (50 AC)							
PEST/PCB (ug/kg)									
Total PCB	20	71 T	516 TJ		270 T				

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Table 4

SEDIMENT SAMPLE OBSERVED RELEASE
50% TO 75% PERCENT TOTAL FINES

STATION NO. EPA SAMPLE NO. PERCENT TOTAL FINES	METHOD REPORTING LIMITS [A]	BACK-GROUND VALUE	SD-DR070-0000 98334017 67.96	SD-DR077-0000 98354017 69.41	SD-DR081-0000 98364003 58.39	SD-DR084-0000 98364006 50.91	SD-DR088-0000 98364009 74.99	SD-DR111-0000-CC 98344055 70.10	SD-DR123-0000 98384002 74.85
Pages in Reference 6			3028, 3152	2203, 2879, 3079	941, 2089, 2837B, 3055	944, 2840, 3055	947, 2843, 3060	429, 3045	682, 1939, 2769, 3066, 3264
BNA (ug/kg)									
Anthracene	20	40							120
Benz(a)anthracene	20	140							460
Benzo(a)pyrene	20	123.33		410					530
Benzo(b)fluoranthene	20	166.67		580					560
Benzo(k)fluoranthene	20	173.33							
Bis(2-ethylhexyl) Phthalate	20	285			1500				
Chrysene	20	250							
Dibenz(a,h)anthracene	20	20							100
Fluoranthene	20	786.67							
Fluorene	20	20							
Indeno(1,2,3-cd)pyrene	20	86.67							400
Phenanthrene	20	253.33							
Pyrene	20	740							
INORGANIC (mg/kg)									
Arsenic	0.5	10.63			40.7				52.4
Cadmium	0.2	0.24			2.8	0.8	1.0		0.8
Chromium	2	24.33							
Copper	2	32.67					187		204
Mercury	0.05	0.09		0.32	0.39	0.27	0.29		0.45
Nickel	0.2	21							
ORGANOTN (ug/kg)									
Di-n-butyltin	20	1 JL (10 AC)	48 (10)						
Tri-n-butyltin	20	5 JL (50 AC)	200 (10)						216 (5)
PEST/PCB (ug/kg)									
Total PCB	20	71 T			1473 TJL	326 TJL	1010 TJL	311 T	900 T

A = Method reporting limits are uniform for all samples evaluated unless another value is listed with the sample result. This values will appear in parenthesis along with the sample result.

Table 4

SEDIMENT SAMPLE OBSERVED RELEASE
50% TO 75% PERCENT TOTAL FINES

STATION NO. EPA SAMPLE NO. PERCENT TOTAL FINES	METHOD REPORTING LIMITS [A]	BACKGROUND VALUE	SD-DR139-0000 98384004 65.97	SD-DR149-0000 98344061 67.38	SD-DR174-0000 98344098 50.58 J	SD-DR175-0000 98344097 64.36 J	SD-DR178-0000-CC 98354000 73.11
Pages in Reference 6			684, 1944, 1945, 2771, 3066	1515, 1516, 3045	779, 2004, 2005, 3052	2001, 2002, 3052	884, 2151, 2152, 2862, 3052
BNA (ug/kg)							
Anthracene	20	40	460	220	330	1500	540
Benz(a)anthracene	20	140		600	1500	3000	2600
Benzo(a)pyrene	20	123.33		390	1100	1200	
Benzo(b)fluoranthene	20	166.67	510		1500	2000	
Benzo(k)fluoranthene	20	173.33			1000	1300	
Bis(2-ethylhexyl) Phthalate	20	285	2500				5100
Chrysene	20	250			1800	3400	3500
Dibenz(a,h)anthracene	20	20	80		130	150	
Fluoranthene	20	786.67			2800	18000 (200)	3500
Fluorene	20	20	140	110	120	1700	180
Indeno(1,2,3-cd)pyrene	20	86.67			480	660	
Phenanthrene	20	253.33		820		16000 (200)	2400
Pyrene	20	740			2600	11000 (200)	7400
INORGANIC (mg/kg)							
Arsenic	0.5	10.63					
Cadmium	0.2	0.24	0.9				2.74 (0.02)
Chromium	2	24.33					
Copper	2	32.67					
Mercury	0.05	0.09	0.82				0.42
Nickel	0.2	21					
ORGANOTN (ug/kg)							
Di-n-butyltin	20	1 JL (10 AC)					
Tri-n-butyltin	20	5 JL (50 AC)					
PEST/PCB (ug/kg)							
Total PCB	20	71 T	2840 T		494 T		6366 TJL

A = Method reporting limits are uniform for all samples evaluated unless another value is listed with the sample result. This values will appear in parenthesis along with the sample result.

Table 4

SEDIMENT SAMPLE OBSERVED RELEASE
50% TO 75% PERCENT TOTAL FINES

STATION NO.	METHOD REPORTING LIMITS [A]	BACKGROUND VALUE	SD-DR180-0000	SD-DR186-0000	SD-DR201-0000	SD-DR210-0000	SD-DR217-0000	SD-DR221-0000	SD-DR239-0000
EPA SAMPLE NO.			98354004	98354072	98354064	98354031	98344065	98334056	98354068
PERCENT TOTAL FINES			69.37	66.29 J	53.26	60.48	54.97	73.57 J	64.18 J
Pages in Reference 6			888, 3052	1103, 2324, 2325, 2932, 3054	1088, 3054	1033, 2899, 3079	270, 1525, 2589, 3045	1610, 1611, 3034	2312, 2313, 3054
BNA (ug/kg)									
Anthracene	20	40		330				140	
Benz(a)anthracene	20	140		930			470	1000	
Benzo(a)pyrene	20	123.33		830			440	460	
Benzo(b)fluoranthene	20	166.67		840			730	510	
Benzo(k)fluoranthene	20	173.33		700					
Bis(2-ethylhexyl) Phthalate	20	285					1000		
Chrysene	20	250		1100				840	
Dibenz(a,h)anthracene	20	20		120			90		
Fluoranthene	20	786.67						4200	
Fluorene	20	20		300				90	90
Indeno(1,2,3-cd)pyrene	20	86.67		510			280		
Phenanthrene	20	253.33		1700				790	1200
Pyrene	20	740						2700	
INORGANIC (mg/kg)									
Arsenic	0.5	10.63							
Cadmium	0.2	0.24		1.0			0.9 (0.1)		
Chromium	2	24.33		180					
Copper	2	32.67		157					
Mercury	0.05	0.09				0.46			
Nickel	0.2	21		96.4					
ORGANOTN (ug/kg)									
Di-n-butyltin	20	1 JL (10 AC)							
Tri-n-butyltin	20	5 JL (50 AC)							
PEST/PCB (ug/kg)									
Total PCB	20	71 T	527 TJL	1178 T	655 T	375 T	4200 TJL		

A = Method reporting limits are uniform for all samples evaluated unless another value is listed with the sample result. This values will appear in parenthesis along with the sample result.

Table 5

SEDIMENT SAMPLES OBSERVED RELEASE
75% TO 100% TOTAL FINES

STATION NO. EPA SAMPLE NO. TOTAL PERCENT FINES	METHOD REPORTING LIMITS [A]	BACKGROUND VALUE	SD-DR002-0000 98334002 85.75	SD-DR005-0000 98344022 78.13	SD-DR011-0000 98344028 78.47	SD-DR015-0000 98344000 92.37	SD-DR016-0000 98344001 87.57	SD-DR021-0000 98344005 86.26 J	SD-DR038-0000 98364030 77.90
Pages in Reference 6			1340, 3028	1786, 3039	508, 1804, 3039	1469, 3035	1472, 3035	1484, 3035	2136, 2137, 3066
BNA (ug/kg)									
Anthracene	20	25	130	130	120	220	320	220	1600
Benz(a)anthracene	20	103.33	490			690	810	650	2000
Benzo(a)pyrene	20	103.33		520		570	570	560	1100
Benzo(b)fluoranthene	20	150		720		750	720	720	1400
Benzo(k)fluoranthene	20	140							980
Bis(2-ethylhexyl) Phthalate	20	515		1700					
Chrysene	20	170				1000	1200	970	2200
Dibenz(a,h)anthracene	20	20	80	70		90	80	90	130
Fluoranthene	20	316.67				2500	2200	1400	7800 (200)
Fluorene	20	30							580
Indeno(1,2,3-cd)pyrene	20	76.67		320		360	340	370	560
Phenanthrene	20	133.33				800			3600
Pyrene	20	306.67							4600
INORGANIC (mg/kg)									
Cadmium	0.02	0.33							
Copper	2	41.33							
Mercury	0.05	0.12							
PEST/PCB (ug/kg)									
Total PCB	20	181.5 T			1537 TJL				

Notes:
A = Method reporting limits are uniform for all samples evaluated unless another value is listed with the sample result. This values will appear in parenthesis along with the sample result.

Table 5

SEDIMENT SAMPLES OBSERVED RELEASE
75% TO 100% TOTAL FINES

STATION NO. EPA SAMPLE NO. TOTAL PERCENT FINES	METHOD REPORTING LIMITS [A]	BACKGROUND VALUE	SD-DR041-0000 98334014 88.53	SD-DR048-0000 98334018 82.64	SD-DR050-0000 98364010 85.64	SD-DR055-0000 98364035 89.58	SD-DR059-0000 98344027 91.99	SD-DR061-0000 98344032 82.02	SD-DR065-0000 98344017 81.56
Pages in Reference 6			1381, 3028	1393, 3028	2109, 2110, 3060	2022, 3066	1801, 3039	1774, 3039	1448, 1449, 3039
BNA (ug/kg)									
Anthracene	20	25	130	260	910	110	200	240	1900
Benz(a)anthracene	20	103.33		840	1600		490	480	930
Benzo(a)pyrene	20	103.33			820		480	490	
Benzo(b)fluoranthene	20	150			1100			700	
Benzo(k)fluoranthene	20	140			750		660		
Bis(2-ethylhexyl) Phthalate	20	515					2500		
Chrysene	20	170		1100	2100				980
Dibenz(a,h)anthracene	20	20	60	70	120	70	70	70	60
Fluoranthene	20	316.67			6700 (200)				4200
Fluorene	20	30			330				2100
Indeno(1,2,3-cd)pyrene	20	76.67			420			320	
Phenanthrene	20	133.33			1400		790		8900 (200)
Pyrene	20	306.67			4200				2900
INORGANIC (mg/kg)									
Cadmium	0.02	0.33							
Copper	2	41.33							
Mercury	0.05	0.12							
PEST/PCB (ug/kg)									
Total PCB	20	181.5 T							

Notes:
A = Method reporting limits are uniform for all samples evaluated unless another value is listed with the sample result. This values will appear in parenthesis along with the sample result.

Table 5

SEDIMENT SAMPLES OBSERVED RELEASE
75% TO 100% TOTAL FINES

STATION NO. EPA SAMPLE NO. TOTAL PERCENT FINES	METHOD REPORTING LIMITS [A]	BACKGROUND VALUE	SD-DR082-0000 98364004 79.10	SD-DR083-0000 98364005 84.75	SD-DR086-0000 98364008 85.90	SD-DR097-0000 98344074 86.78	SD-DR112-0000 98344050 79.41	SD-DR120-0000 98334031 84.26	SD-DR126-0000 98334033 82.03 J
Pages in Reference 6			2092, 3055	2095, 3055	2103, 2104, 3060	1645, 1646, 3045	1690, 3044	1307, 1308, 2506, 3029	1314, 3029
BNA (ug/kg)									
Anthracene	20	25	90	100	160	1500	320	480	180
Benz(a)anthracene	20	103.33				1100	1100	2400	490
Benzo(a)pyrene	20	103.33	480	490		670	790	620	
Benzo(b)fluoranthene	20	150				1000	1300	2000	
Benzo(k)fluoranthene	20	140				730	800	890	
Bis(2-ethylhexyl) Phthalate	20	515							
Chrysene	20	170				1700	1500	3300	
Dibenz(a,h)anthracene	20	20	80	80		70	110	160	70
Fluoranthene	20	316.67				2700	5300	14000 (200)	
Fluorene	20	30			260	360		190	
Indeno(1,2,3-cd)pyrene	20	76.67	340	310		350	470	470	
Phenanthrene	20	133.33			1500	1400	800	3900	
Pyrene	20	306.67				1900	2800	4900	
INORGANIC (mg/kg)									
Cadmium	0.02	0.33							
Copper	2	41.33						181	
Mercury	0.05	0.12							
PEST/PCB (ug/kg)									
Total PCB	20	181.5 T							

Notes:
A = Method reporting limits are uniform for all samples evaluated unless another value is listed with the sample result. This values will appear in parenthesis along with the sample result.

Table 5

SEDIMENT SAMPLES OBSERVED RELEASE
75% TO 100% TOTAL FINES

STATION NO. EPA SAMPLE NO. TOTAL PERCENT FINES	METHOD REPORTING LIMITS [A]	BACKGROUND VALUE	SD-DR132-0000 98334041 77.45	SD-DR155-0000 98334042 80.21 J	SD-DR160-0000 98334032 84.13 J	SD-DR176-0000 98364019 76.19	SD-DR177-0000 98354003 85.85 J	SD-DR179-0000 98354002 77.81	SD-DR185-0000 98354073 86.57 J
Pages in Reference 6			1565, 1566, 3034	1569, 3034	1310, 1311, 3029	2396, 2397, 3060	887, 2161, 3052	886, 2158, 2864, 3052	2328, 3054
BNA (ug/kg)									
Anthracene	20	25	440	180		500	130	210	
Benz(a)anthracene	20	103.33	600		550	880		1200	
Benzo(a)pyrene	20	103.33				490		1700	
Benzo(b)fluoranthene	20	150						2400	
Benzo(k)fluoranthene	20	140						1700	
Bis(2-ethylhexyl) Phthalate	20	515		2500	1900			2800	
Chrysene	20	170	830			1100		1700	780
Dibenz(a,h)anthracene	20	20	60		60	80		250	60
Fluoranthene	20	316.67	2600			3900		2300	1400
Fluorene	20	30	310		170	1000			
Indeno(1,2,3-cd)pyrene	20	76.67						1100	
Phenanthrene	20	133.33	2400		1200	3900		1100	
Pyrene	20	306.67	1900			2500		3700	
INORGANIC (mg/kg)									
Cadmium	0.02	0.33						1.84	
Copper	2	41.33							
Mercury	0.05	0.12						1.12	
PEST/PCB (ug/kg)									
Total PCB	20	181.5 T					632 TJL	3358 TJL	

Notes:
A = Method reporting limits are uniform for all samples evaluated unless another value is listed with the sample result. This values will appear in parenthesis along with the sample result.

Table 5

SEDIMENT SAMPLES OBSERVED RELEASE
75% TO 100% TOTAL FINES

STATION NO. EPA SAMPLE NO. TOTAL PERCENT FINES	METHOD REPORTING LIMITS [A]	BACKGROUND VALUE	SD-DR191-0000 98334061 84.92	SD-DR219-0000 98384007 87.85 J
Pages in Reference 6			1630, 3035	1954, 3066
BNA (ug/kg)				
Anthracene	20	25	160	100
Benz(a)anthracene	20	103.33	920	
Benzo(a)pyrene	20	103.33		
Benzo(b)fluoranthene	20	150		
Benzo(k)fluoranthene	20	140		
Bis(2-ethylhexyl) Phthalate	20	515		
Chrysene	20	170	870	
Dibenz(a,h)anthracene	20	20		80
Fluoranthene	20	316.67	2800	
Fluorene	20	30		
Indeno(1,2,3-cd)pyrene	20	76.67		370
Phenanthrene	20	133.33	760	
Pyrene	20	306.67	1900	
INORGANIC (mg/kg)				
Cadmium	0.02	0.33		
Copper	2	41.33		
Mercury	0.05	0.12		
PEST/PCB (ug/kg)				
Total PCB	20	181.5 T		

Notes:

A = Method reporting limits are uniform for all samples evaluated unless another value is listed with the sample result. This values will appear in parenthesis along with the sample result.

The Boeing Company Phase I Site Characterization Report (Ref. 7)

The Boeing Company (Boeing) performed a Phase I Surface Sampling Screening in October 1997 (Ref. 7, p. 9). The objective of the Phase I sampling design was to generate information that could be used as a first step in evaluating potential chemical releases to the Duwamish Waterway that could be attributable exclusively to Boeing (Ref. 7, p. 9). The sampling design focused on sediment sampling in the vicinity of the outfalls located adjacent to Boeing facilities along the Duwamish Waterway (Ref. 7, p. 9). A total of 88 3-part composite surface (0 to 10 centimeters) sediment samples were collected at stations adjacent to Boeing facilities and in Slips 4 and 6 (Ref. 7, pp. 10, 21, 23, 43, 44, 45). Sediments off of Boeing Plant 2 were not addressed in the Phase I sampling because they are the subject of a remedial investigation (Ref. 7, pp. 10 and 44). Boeing determined not to collect samples from the navigational channel since the channel had been dredged several times over the years, and chemicals historically deposited there had likely been removed or mixed with sediments from other locations during these dredging activities (Ref. 7, p. 20).

Samples were analyzed for PCBs aroclors and hexachlorobenzene (SW-846 Method), SVOCs (SW-846 Method 8270B), the metals arsenic cadmium, chromium, copper, lead, nickel, silver, zinc (EPA Method 200.8), mercury (SW-846 Method 7471), TOC (Plumb and PSEP), total solids (EPA Method 160.3M), and grain size distribution (Method number not provided) (Ref. 7, pp. 19, 24, and 136). Samples were collected with decontaminated stainless steel equipment (i.e., van Veen grab sampler, Ponar grab sampler, or spoons) and were homogenized in stainless steel bowls (Ref. 7, p. 26). Immediately after sample containers were filled, they were placed on ice at 4°C (Ref. 7, p. 27). Samples were retained at this temperature from the time that they were collected until they were hand delivered to the laboratory (Ref. 7, p. 27). Chain-of-custody forms were delivered with the samples to the laboratory (Ref. 7, pp. 27 and 134). Following laboratory analysis, sample results underwent a quality assurance review (Ref. 7, pp. 128 through 147). Based on this review, a majority of the data quality issues that were identified did not affect the major chemicals of concern (Ref. 7, p. 132). All quality control critieria used to evaluate the analytes used in the following observed release tables were considered acceptable (Ref. 7, p. 133).

Three upstream reference (background) samples were collected (Ref. 7, pp. 45 and 134). Since grain size distributions were not provided in the final report, the highest concentration per analyte of the three background samples was used in determining observed releases. Selected analytical results of samples collected between RK 2.5 and RK 11.5 that document an observed release by chemical analysis are provided in Table 6 below (Ref. 1, p. 51589, Section 2.3). Not all analytes meeting observed release criteria are presented. Results for total PCBs were calculated by Boeing (Ref. 7, p. 74). Blank cells in the table are for sample results that did not document an observed release.

Table 6

OBSERVED RELEASES TO SURFACE SEDIMENTS[1]
BOEING COMPANY SEDIMENT SAMPLES

Sample Number	Total PCB[2] (ug/kg dry weight)	Total Mercury (mg/kg dry weight)	Benz(a)-anthracene (ug/kg dry weight)	Benzo(a)-pyrene (ug/kg dry weight)	Dibenz(a,h)-anthracene (ug/kg dry weight)	Reference
REF-1 (Background)	40 U[3]	0.08 U	160	180	21	Ref. 7, pp. 74, 77, 83
REF-2 (Background)	37 U[3]	0.05 U	19 U	19 U	19 U	Ref. 7, pp. 74, 77, 83
REF-3 (Background)	38 U[3]	0.07 U	170	170	22	Ref. 7, pp. 74, 77, 83

Table 6

OBSERVED RELEASES TO SURFACE SEDIMENTS[1]
BOEING COMPANY SEDIMENT SAMPLES

Sample Number	Total PCB[2] (ug/kg dry weight)	Total Mercury (mg/kg dry weight)	Benz(a)-anthracene (ug/kg dry weight)	Benzo(a)-pyrene (ug/kg dry weight)	Dibenz(a,h)-anthracene (ug/kg dry weight)	Reference
Highest Background Result	40 U	0.08 U	170	180	22	
SD0001	160	0.10				Ref. 7, pp. 72, 75
SD0002	160	0.13				Ref. 7, pp. 72, 75
SD0003		0.12	660	580	170	Ref. 7, pp. 75, 81
SD0004	170	0.12			73	Ref. 7, pp. 72, 75, 81
SD0005	160	0.12	710	580	150	Ref. 7, pp. 72, 75, 81
SD0006	150	0.11				Ref. 7, pp. 72, 75
SD0007	1200	0.14				Ref. 7, pp. 72, 75
SD0008	400	0.16				Ref. 7, pp. 72, 75
SD0009	3000	0.20	700	1100		Ref. 7, pp. 72, 75, 81
SD0010	3200	0.38	930			Ref. 7, pp. 72, 75, 81
SD0011	1800	0.20	580	990		Ref. 7, pp. 72, 75, 81
SD0012	1600	0.12				Ref. 7, pp. 72, 75
SD0013	1300	0.14				Ref. 7, pp. 72, 75
SD0014	16000	0.34				Ref. 7, pp. 72, 75
SD0015	1400	0.19				Ref. 7, pp. 72, 75
SD0016	2400	0.09				Ref. 7, pp. 72, 75
SD0017	180	0.10				Ref. 7, pp. 72, 75
SD0018	200				70	Ref. 7, pp. 72, 81
SD0019	190	0.12				Ref. 7, pp. 72, 75
SD0020	170	0.17				Ref. 7, pp. 72, 75
SD0021	200	0.34				Ref. 7, pp. 72, 75
SD0022	180	0.11	2100	2400	510	Ref. 7, pp. 72, 75, 81
SD0023	870	0.10	3900	4500	1200	Ref. 7, pp. 72, 75, 81
SD0024	73	0.09				Ref. 7, pp. 72, 75

Table 6

OBSERVED RELEASES TO SURFACE SEDIMENTS[1]
BOEING COMPANY SEDIMENT SAMPLES

Sample Number	Total PCB[2] (ug/kg dry weight)	Total Mercury (mg/kg dry weight)	Benz(a)-anthracene (ug/kg dry weight)	Benzo(a)-pyrene (ug/kg dry weight)	Dibenz(a,h)-anthracene (ug/kg dry weight)	Reference
SD0025	75	0.09				Ref. 7, pp. 72, 75
SD0026	160	0.10			83	Ref. 7, pp. 72, 75, 81
SD0027	340	0.17			95	Ref. 7, pp. 72, 75, 81
SD0028	41					Ref. 7, p. 72
SD0029	52	0.09				Ref. 7, pp. 72, 75
SD0030		0.09			100	Ref. 7, pp. 75, 81
SD0031	120	0.10			100	Ref. 7, pp. 72, 75, 81
SD0032	42					Ref. 7, p. 72
SD0033	46					Ref. 7, p. 72
SD0034	91	0.12				Ref. 7, pp. 72, 75
SD0035	130					Ref. 7, p. 72
SD0036	54					Ref. 7, p. 72
SD0037	45	0.10				Ref. 7, pp. 73, 76
SD0038	13	0.11				Ref. 7, pp. 73, 76
SD0039	20	0.11				Ref. 7, pp. 73, 76
SD0040	120	0.09	21000	21000	7200	Ref. 7, pp. 73, 76, 82
SD0041	170	0.15	590	780	240	Ref. 7, pp. 73, 76, 82
SD0042	190		5000	5700	2000	Ref. 7, pp. 73, 82
SD0043	110				72	Ref. 7, pp. 73, 82
SD0044		0.10	630	870		Ref. 7, pp. 76, 82
SD0045	100	0.10	3000	3400	640	Ref. 7, pp. 73, 76, 82
SD0046	100	0.10				Ref. 7, pp. 73, 76
SD0047	66	0.10				Ref. 7, pp. 73, 76
SD0048	94	0.10				Ref. 7, pp. 73, 76
SD0049	56	0.09				Ref. 7, pp. 73, 76
SD0050	53					Ref. 7, p. 73

Table 6

OBSERVED RELEASES TO SURFACE SEDIMENTS[1]
BOEING COMPANY SEDIMENT SAMPLES

Sample Number	Total PCB[2] (ug/kg dry weight)	Total Mercury (mg/kg dry weight)	Benz(a)-anthracene (ug/kg dry weight)	Benzo(a)-pyrene (ug/kg dry weight)	Dibenz(a,h)-anthracene (ug/kg dry weight)	Reference
SD0051	66	0.10				Ref. 7, pp. 73, 76
SD0052	50	0.10	570	580		Ref. 7, pp. 73, 76, 82
SD0053				530	86	Ref. 7, p. 82
SD0054	75					Ref. 7, p. 73
SD0055	62	0.10				Ref. 7, pp. 73, 76
SD0056	81					Ref. 7, p. 73
SD0057	48					Ref. 7, p. 73
SD0059	50					Ref. 7, p. 73
SD0062	60	0.10		520	170	Ref. 7, pp. 73, 76, 82
SD0063	100	0.12	810	940	280	Ref. 7, pp. 73, 76, 82
SD0064	63	0.11				Ref. 7, pp. 73, 76
SD0065	80				77	Ref. 7, pp. 73, 82
SD0066	55					Ref. 7, p. 73
SD0067	74					Ref. 7, p. 73
SD0068	88					Ref. 7, p. 73
SD0073	99	0.10				Ref. 7, pp. 74, 77
SD0074	120	0.11				Ref. 7, pp, 74, 77
SD0075	260	0.10				Ref. 7, pp. 74, 77
SD0077	100		700	620		Ref. 7, pp. 74, 83
SD0079	46					Ref. 7, p. 74
SD0081	90					Ref. 7, p. 74
SD0084	99	0.09				Ref. 7, pp. 74, 77
SD0085	44	0.08				Ref. 7, pp. 74, 77
SD0086	110					Ref. 7, p. 74
SD0087	8400	0.11				Ref. 7, pp. 74, 77
SD0088	180	0.10				Ref. 7, pp. 74, 77

Key

[1] - Sample results listed in Reference 7 tables associated with the revised sample number column are the sample numbers and results used.
[2] - Total PCBs as calculated by Boeing (Ref. 7, p. 74).
[3] - When all Aroclors that were used to derive the Total PCB value were undetected, the highest undetected Aroclor value is used as the Total PCB value.
mg/kg - milligrams per kilogram.
U - The analyte was undetected at the indicated detection limit (Ref. 7, pp. 74, 77, 83).
ug/kg - microgram per kilogram.

National Oceanic and Atmospheric Administration Duwamish Waterway Sediment Characterization Study (Ref. 8)

In 1997, the Natural Resource Trustees for the Duwamish River initiated an investigation to evaluate the extent and severity of PCB and polychlorinated terphenyl (PCT) contamination in the sediments of the Duwamish Waterway (Ref. 8, p. 6). The Trustees' investigation focused on the Duwamish Waterway from 1.5 KM upriver of Turning Basin #3 to the southern tip of Harbor Island (Ref. 8, p. 7). In total, the Trustees collected 328 sediment samples within the Waterway (Ref. 8, p. 14; Ref. 25). The analytical results for this study were compared to Washington State Sediment Quality Standard (SQS) (Ref. 8, pp. 17 and 18). The major findings of the sediment characterization indicate that almost 71 acres of the 350 acre sampled area of the Waterway, or just under 20 percent, are estimated to have PCB contaminant levels that exceed the Washington State SQS (Ref. 8, pp. 2, 7, and 9). The most contaminated region was the middle portion of the Waterway, north of Slip 6 and south of Slip 2 (Ref. 8, pp. 2 and 8). Seventeen of 18 samples collected from within Slip 4 exceeded the SQS for PCBs (Ref. 8, pp. 2 and 8). Concentrations of PCBs at many sample points in the middle portion of the Waterway are 10 to 100 times the Washington State SQS; based on published studies of the exposure, uptake, and bioaccumulation of PCBs by organisms (Ref. 8, p. 2). The quantity and concentrations of PCBs found in Duwamish Waterway sediments are potentially sufficient to cause injuries to natural resources (Ref. 8, pp. 2, 19, and 24).

All samples were collected in accordance with the Sampling and Analysis Plan for the Duwamish River Sediment Study (Ref. 8, p. 14; Ref. 27, pp. 2 through 84). All sediment samples were collected with dedicated or decontaminated stainless steel sampling equipment and were placed into precleaned containers (Ref. 27, pp. 15, 16, and 23). Sample containers were stored in coolers with ice and were shipped under chain-of-custody to analytical laboratories (Ref. 8, pp. 86 and 88; Ref. 16; Ref. 27, pp. 18 and 22). All sediment samples were collected from the upper 10 centimeter of material retained for analyses (Ref. 27, p. 15). Field operations were conducted from September to November 1997 (Ref. 8, p. 14; Ref. 30). Sediment samples were analyzed for PCBs, PCTs, (both using a modification of NWFSC-ECD procedures), TOC (using Puget Sound Protocols for Measuring Conventional Sediment Variables), and grain size (following the procedures in Sweet et al.) (Ref. 8, p. 15; Ref. 27, p. 89 and 90).

Background samples were selected for determining observed release concentrations by considering contaminant variances expected as a function of grain size. In selecting background concentrations, first all sediment samples were divided into four grain size classifications (0 – 25%, 25 – 50%, 50 – 75%, and 75 to 100%) based on the percent of total fines present (i.e., particles smaller than sands) (Ref. 18; Ref. 19), then three relatively upstream samples were selected from each grain size classification to represent background conditions. Finally, the results for the selected background samples in each grain size classification were averaged. These averages were used when determining observed releases. To calculate the average background concentration, all of the selected background concentrations were added and then the sum was divided by the number of background samples used for that analyte and grain size classification.

Only total PCBs as calculated by NOAA were used to document observed releases in the following tables (Table 7 through Table 10) (Ref. 1, Section 2.3; Ref. 8, p. 36).

Table 7

OBSERVED RELEASES TO SURFACE SEDIMENTS
NOAA 1997 SEDIMENT SAMPLES
0% TO 25% TOTAL FINES

LOCATION ID	% TOTAL FINES	TOTAL PCBs (ng/g or ug/kg)	SQL (ng/g or ug/kg)	REFERENCE
DAC-ESTUPRVR01	0.35	0.63 U	0.63 U	Ref. 8, pp. 34, 43, 69; Ref. 19; Ref. 29
DAC-EIT01-02	10.84	5.5	2.92 U	Ref. 8, pp. 34, 39, 59; Ref. 19; Ref. 29
DAC-EIT01-01	3.53	3.2	2.92 U	Ref. 8, pp. 34, 39, 59; Ref. 19; Ref. 29
Average Background Concentration		**4.35**		
DAC-EIT02-04	24.4	140	3.49 U	Ref. 8, pp. 34, 39, 59; Ref. 19; Ref. 29
DAC-EIT06-02	16.93	2400	8.91 U	Ref. 8, pp. 34, 39, 60; Ref. 19; Ref. 29
DAC-EIT07-02-1	15.58	1800	4.87 U	Ref. 8, pp. 34, 39, 60; Ref. 19; Ref. 29
DAC-EIT08-02	14.22	25000	2.57 U	Ref. 8, pp. 34, 39, 60; Ref. 19; Ref. 29
DAC-EIT09-01	22.06	450	3.35 U	Ref. 8, pp. 34, 39, 60; Ref. 19; Ref. 29
DAC-EIT10-01	9.78	240	2.59 U	Ref. 8, pp. 34, 40, 61; Ref. 19; Ref. 29
DAC-EIT11-02	12.26	49	2.72 U	Ref. 8, pp. 34, 40, 61; Ref. 19; Ref. 29
DAC-EIT12-02-5	3.88	14	2.48 U	Ref. 8, pp. 34, 40, 61; Ref. 19; Ref. 29
DAC-EIT14-01	5.96	28	1.67 U	Ref. 8, pp. 34, 40, 61; Ref. 19; Ref. 29
DAC-EST03-05-R	15.63	87	3.80 U	Ref. 8, pp. 34, 40, 62; Ref. 19; Ref. 29
DAC-WIT04-02	9.9	46	2.30 U	Ref. 8, pp. 34, 44, 79; Ref. 19; Ref. 29
DAC-WIT05-02	21.63	51	4.33 U	Ref. 8, pp. 34, 44, 79; Ref. 19; Ref. 29
DAC-WIT07-01	8.75	2400	3.18 U	Ref. 8, pp. 34, 44, 80; Ref. 19; Ref. 29
DAC-WIT08-06	6.35	64	4.61 U	Ref. 8, pp. 34, 44, 80; Ref. 19; Ref. 29
DAC-WIT09-02	16.27	120	1.98 U	Ref. 8, pp. 34, 45, 80; Ref. 19; Ref. 29
DAC-WIT12-08	21.72	230	2.57 U	Ref. 8, pp. 34, 45, 80; Ref. 19; Ref. 29
DAC-WST14-01-2	8.25	38	3.36 U	Ref. 8, pp. 34, 46, 76; Ref. 19; Ref. 29
DAC-WST16-02-1	13.19	56	4.34 U	Ref. 8, pp. 34, 46, 76; Ref. 19; Ref. 29

Key:
ID = Identification.
SQL = Sample quantitation limit.
ng/g = nanograms per gram.
NOAA = National Oceanic and Atmospheric Administration.
PCBs = Polychlorinated biphenyls.
ug/kg = micrograms per kilogram.

OBSERVED RELEASES TO SURFACE SEDIMENTS
NOAA 1997 SEDIMENT SAMPLES
25% TO 50% TOTAL FINES

LOCATION ID	% TOTAL FINES	TOTAL PCBs (ng/g or ug/kg)	SQL (ng/g or ug/kg)	REFERENCE
DAC-EITUPRVR02	42.73	2.7	5.99 U	Ref. 8, pp. 34, 40, 61; Ref. 19; Ref. 29
DAC-EITUPRVR01	48.51	7.9	5.13 U	Ref. 8, pp. 34, 40, 61; Ref. 19; Ref. 29
DAC-WIT01-05	46.31	3.4	2.15 U	Ref. 8, pp. 34, 44, 79; Ref. 19; Ref. 29
Average Background Concentration		**4.7**		
DAC-CH05-01	47.58	220	5.48 U	Ref. 8, pp. 34, 38, 70; Ref. 19; Ref. 29
DAC-CH13-01	45.29	78	3.52 U	Ref. 8, pp. 34, 39, 72; Ref. 19; Ref. 29
DAC-EIT04-02	46.93	41	4.74 U	Ref. 8, pp. 34, 40, 59; Ref. 19; Ref. 29
DAC-EIT04-03	30.61	65	3.59 U	Ref. 8, pp. 34, 40, 59; Ref. 19; Ref. 29
DAC-EIT08-01-R	32.78	3300	5.29 U	Ref. 8, pp. 34, 40, 60; Ref. 19; Ref. 29
DAC-EST11-11-R	35.83	160	4.33 U	Ref. 8, pp. 34, 42, 65; Ref. 19; Ref. 29
DAC-EST13-04	41.06	240	2.96 U	Ref. 8, pp. 34, 42, 66; Ref. 19; Ref. 29
DAC-EST21-03	43.43	4400	5.02 U	Ref. 8, pp. 34, 43, 68; Ref. 19; Ref. 29
DAC-WIT03-04	34.78	43	2.93 U	Ref. 8, pp. 34, 44, 79; Ref. 19; Ref. 29
DAC-WIT05-01	47.59	340	4.63 U	Ref. 8, pp. 34, 44, 79; Ref. 19; Ref. 29
DAC-WIT07-02	36.38	550	3.55 U	Ref. 8, pp. 34, 44, 80; Ref. 19; Ref. 29
DAC-WIT08-05	48.8	70	6.98 U	Ref. 8, pp. 34, 44, 80; Ref. 19; Ref. 29
DAC-WIT09-01-R5	49.1	200	2.84 U	Ref. 8, pp. 34, 45, 80; Ref. 19; Ref. 29
DAC-WIT11-01	25.53	5200	2.83 U	Ref. 8, pp. 34, 45, 81; Ref. 19; Ref. 29
DAC-WIT12-01-R	43.56	770	3.69 U	Ref. 8, pp. 34, 45, 81; Ref. 19; Ref. 29
DAC-WST03-01	47.18	26	3.54 U	Ref. 8, pp. 34, 45, 74; Ref. 19; Ref. 29
DAC-WST20-02	32.81	29	2.70 U	Ref. 8, pp. 34, 47, 77; Ref. 19; Ref. 29

Key:
ID = Identification.
SQL = Sample quantitation limit.
ng/g = nanograms per gram.
NOAA = National Oceanic and Atmospheric Administration.
PCBs = Polychlorinated biphenyls.
ug/kg = micrograms per kilogram.

Table 9

OBSERVED RELEASES TO SURFACE SEDIMENTS
NOAA 1997 SEDIMENT SAMPLES
50% TO 75% TOTAL FINES

LOCATION ID	% TOTAL FINES	TOTAL PCBs (ng/g or ug/kg)	SQL (ng/g or ug/kg)	REFERENCE
DAC-WIT01-04	56.36	96	4.95 U	Ref. 8, pp. 34, 44, 79; Ref. 19; Ref. 29
DAC-WIT01-02	65	46	6.91 U	Ref. 8, pp. 34, 44, 79; Ref. 19; Ref. 29
DAC-WIT02-02	59.16	19	3.94 U	Ref. 8, pp. 34, 44, 79; Ref. 19; Ref. 29
Average Background Concentration		**53.7**		
DAC-CH05-02	60.1	430	4.20 U	Ref. 8, pp. 34, 38, 70; Ref. 19; Ref. 29
DAC-CH12-01-2	70.5	1400	4.73 U	Ref. 8, pp. 34, 38, 72; Ref. 19; Ref. 29
DAC-EST09-04	59.7	1500	7.26 U	Ref. 8, pp. 34, 41, 64; Ref. 19; Ref. 29
DAC-EST10-01	60.62	690	12.59 U	Ref. 8, pp. 34, 41, 64; Ref. 19; Ref. 29
DAC-EST11-12	74.08	230	6.13 U	Ref. 8, pp. 34, 42, 65; Ref. 19; Ref. 29
DAC-EST12-01	57.09	7000	3.99 U	Ref. 8, pp. 34, 42, 65; Ref. 19; Ref. 29
DAC-EST12-08-1	54.22	300	4.34 U	Ref. 8, pp. 34, 42, 65; Ref. 19; Ref. 29
DAC-EST18-04	54.63	180	3.58 U	Ref. 8, pp. 34, 43, 67; Ref. 19; Ref. 29
DAC-EST22-01	70.4	190	2.75 U	Ref. 8, pp. 34, 43, 68; Ref. 19; Ref. 29
DAC-EST23-05	63.57	200	5.04 U	Ref. 8, pp. 34, 43, 69; Ref. 19; Ref. 29
DAC-WIT12-03	62.43	660	4.86 U	Ref. 8, pp. 34, 45, 81; Ref. 19; Ref. 29
DAC-WST09-02	71.68	7600	3.49 U	Ref. 8, pp. 34, 46, 75; Ref. 19; Ref. 29

Key:
ID = Identification.
SQL = Sample quantitation limit.
ng/g = nanograms per gram.
NOAA = National Oceanic and Atmospheric Administration.
PCBs = Polychlorinated biphenyls.
ug/kg = micrograms per kilogram.

Table 10

OBSERVED RELEASES TO SURFACE SEDIMENTS
NOAA 1997 SEDIMENT SAMPLES
75% TO 100% TOTAL FINES

LOCATION ID	% TOTAL FINES	TOTAL PCBs (ng/g or ug/kg)	SQL (ng/g or ug/kg)	REFERENCE
DAC-WIT03-01	77.92	34	3.92 U	Ref. 8, pp. 34, 44, 79; Ref. 19; Ref. 29
DAC-WIT03-05	80.23	6.1	7.08 U	Ref. 8, pp. 34, 44, 79; Ref. 19; Ref. 29
DAC-WST02-02	80.16	60	6.07 U	Ref. 8, pp. 34, 45, 74; Ref. 19; Ref. 29
Average Background Concentration		**33.4**		
DAC-CH07-01	80.39	1200	3.35 U	Ref. 8, pp. 34, 38, 71; Ref. 19; Ref. 29
DAC-CH09-03	93.95	120	3.79 U	Ref. 8, pp. 34, 38, 71; Ref. 19; Ref. 29
DAC-CH11-02	87.06	210	3.79 U	Ref. 8, pp. 34, 38, 71; Ref. 19; Ref. 29
DAC-CH12-02	87.74	130	3.52 U	Ref. 8, pp. 34, 38, 72; Ref. 19; Ref. 29
DAC-EIT05-01	81.03	120	5.12 U	Ref. 8, pp. 34, 39, 59; Ref. 19; Ref. 29
DAC-EST09-01	85.38	110	10.68 U	Ref. 8, pp. 34, 41, 64; Ref. 19; Ref. 29
DAC-EST11-06	78.39	220	7.47 U	Ref. 8, pp. 34, 41, 65; Ref. 19; Ref. 29
DAC-EST12-02	77.09	4100	6.08 U	Ref. 8, pp. 34, 42, 65; Ref. 19; Ref. 29
DAC-EST12-05	78.44	6600	8.67 U	Ref. 8, pp. 34, 42, 65; Ref. 19; Ref. 29
DAC-EST13-02	83.95	200	3.64 U	Ref. 8, pp. 34, 42, 66; Ref. 19; Ref. 29
DAC-EST14-01-R	82.47	250	3.24 U	Ref. 8, pp. 34, 42, 66; Ref. 19; Ref. 29
DAC-EST15-02	86.88	170	3.91 U	Ref. 8, pp. 34, 42, 66; Ref. 19; Ref. 29
DAC-EST16-04	86.81	200	3.18 U	Ref. 8, pp. 34, 42, 67; Ref. 19; Ref. 29
DAC-EST17-01	88.97	300	5.42 U	Ref. 8, pp. 34, 42, 67; Ref. 19; Ref. 29
DAC-EST18-03	77.64	140	3.25 U	Ref. 8, pp. 34, 43, 67; Ref. 19; Ref. 29
DAC-EST19-04	89.02	120	4.34 U	Ref. 8, pp. 34, 43, 67; Ref. 19; Ref. 29
DAC-EST20-04	90.13	700	4.36 U	Ref. 8, pp. 34, 43, 68; Ref. 19; Ref. 29
DAC-EST21-04	90.31	160	4.30 U	Ref. 8, pp. 34, 43, 68; Ref. 19; Ref. 29
DAC-EST22-02	84.2	250	2.47 U	Ref. 8, pp. 34, 43, 68; Ref. 19; Ref. 29
DAC-EST23-06	91.91	140	3.53 U	Ref. 8, pp. 34, 43, 69; Ref. 19; Ref. 29
DAC-WIT12-05	83.72	340	4.43 U	Ref. 8, pp. 34, 45, 81; Ref. 19; Ref. 29
DAC-WST10-07	84.99	160	7.76 U	Ref. 8, pp. 34, 46, 75; Ref. 19; Ref. 29
DAC-WST13-01	94	150	2.98 U	Ref. 8, pp. 34, 46, 76; Ref. 19; Ref. 29
DAC-WST15-03	79.63	140	4.71 U	Ref. 8, pp. 34, 46, 76; Ref. 19; Ref. 29
DAC-WST16-01	91.76	110	5.37 U	Ref. 8, pp. 34, 46, 76; Ref. 19; Ref. 29
DAC-WST17-02	89.57	260	6.33 U	Ref. 8, pp. 34, 46, 76; Ref. 19; Ref. 29
DAC-WST18-05	95.66	140	4.35 U	Ref. 8, pp. 34, 47, 77; Ref. 19; Ref. 29
DAC-WST19-03	90.62	190	4.60 U	Ref. 8, pp. 34, 47, 77; Ref. 19; Ref. 29
DAC-WST21-01	98.34	300	5.23 U	Ref. 8, pp. 34, 47, 77; Ref. 19; Ref. 29

Key:
ID = Identification.
SQL = Sample quantitation limit.
ng/g = nanograms per gram.
NOAA = National Oceanic and Atmospheric Administration.
PCBs = Polychlorinated biphenyls.
ug/kg = micrograms per kilogram.

2.4.2 Hazardous Waste Quantity

2.4.2.1.1 Hazardous Constituent Quantity

Available data are insufficient to document a hazardous constituent quantity (Ref. 1, p. 51590, Section 2.4.2.1.1).

Hazardous Constituent Quantity Value (S): NS

2.4.2.1.2 Hazardous Wastestream Quantity

Available data are insufficient to document a hazardous wastestream quantity (Ref. 1, p. 51590, Section 2.4.2.1.2).

Hazardous Wastestream Quantity Value (W): NS

2.4.2.1.3 Volume

Contaminated sediments are present from RK 2.5 to RK 10.8 (see Section 2.2) a length of 8.3 kilometers or 8,300 meters. The width of contaminated sediments is not known but is estimated to be a minimum of one meter since contamination is known to be present on both sides of the river throughout this segment (see Section 2.2). The depth of contamination is 10 centimeters or 0.1 meter. Therefore, the volume of contaminated sediments is estimated to be a minimum of 830 cubic meters (8,300 meters x 1 meter x 0.1 meter = 830 cubic meters) or 1,085.64 cubic yards (830 cubic meters x 1.308 cubic yards per cubic meter). The value assigned to the volume measure is calculated as follows:

1,085.64 / 2.5 = 434.256

Volume Assigned Value: 434.256
Ref. 1, p. 51591 Table 2-5

2.4.2.1.4 Area

Because the volume was scored, a 0 for the area measure is assigned for this source (Ref. 1, p. 51591, Section 2.4.2.1.4).

Area Assigned Value: 0

==========

Source Hazardous Waste Quantity Factor Value: 434.256

SUMMARY OF SOURCE DESCRIPTIONS

Source No.	Source Hazardous Waste Quantity Value	Containment Value for Surface Water
1. Contaminated Sediments[a]	434.256	10[b]

a - See Section 2.2 of this document
b - Ref. 1, p. 51610, Table 4-2

4.1 OVERLAND /FLOOD MIGRATION COMPONENT

4.1.1.1 Definition of Hazardous Substance Migration Path for Overland/Flood Component

The Duwamish River originates at the confluence of the Green and Black Rivers near Tukwila, Washington, then flows northeast for approximately 21 kilometers, dividing at the southern end of Harbor Island to form the East and West waterways prior to discharging into Elliot Bay (Ref. 4, p. 7). The 15-mile target distance limit (TDL) for this site begins at contaminated NOAA sample point EIT02-04 at RK 10.8, extends 6.8 miles downriver of this location to Elliot Bay on the Puget Sound, and ends as a 8.2 mile arc in Puget Sound (Ref. 3; Ref. 4, p. 993). A portion of the river is maintained by the US ACE as a federal navigation channel (i.e., the reach downchannel of Turning Basin #3) (Ref. 4, p. 7). This portion of the river typically is referred to as the Duwamish Waterway (Ref. 4, p. 7). Stream flow for most of the Duwamish River is regulated by the Howard-Hanson dam upstream of the junction of the Green and Black Rivers (Ref. 4, p. 7). The USACE has limited peak discharges to 12,000 cubic feet per second (cfs) at Tukwila and minimum flows to as low as 200 cfs, with an average flow of 1,500 to 1,800 cfs (Ref. 4, p. 7).

The original topography of the lower Duwamish River valley has been modified (Ref. 4, p. 9). Prior to development of the Duwamish River valley, the land surface consisted of low-lying floodplains and tidal flats (Ref. 4, p. 9). Prior to 1918, the Duwamish River was widely meandering (Ref. 4, p. 9). The natural slips cutting into the riverbank today are the only evidence of the river's original meandering course (Ref. 4, p. 9). During the period between 1910 and 1920, the lower portion of the river was channelized to create the Duwamish Waterway (Ref. 4, p. 9). The former river channel and surrounding floodplains were filled and graded to form the present-day topography (Ref. 4, p. 9).

Tidal effects have been observed throughout the entire reach of the Duwamish River, resulting in characteristic estuarine stratification of the river: surface water is generally fresh or brackish; bottom water is more saline (Ref. 4, p. 7).

The Duwamish River serves as a migratory route, nursery, and osmoregulatory transition zone for several species of Pacific salmon (Ref. 4, p. 9; Ref. 28). In addition, the Duwamish River is part of the traditional fishing grounds for the Muckleshoot and Suquamish Indian tribes (Ref. 4, p. 9). Three salmon hatcheries within the Green-Duwamish River system release approximately 10 million juvenile salmon each year (Ref. 28). The river supports recreational, subsistence, and commercial fishing (Ref. 11, p. 1). The Lower Duwamish River provides a critical migratory pathway for the federally listed threatened Chinook salmon and the federal candidate Coho salmon also used this area (Ref. 28). A nesting territory for the federally listed threatened Bald eagle exists near the mouth of the Duwamish River (Ref. 12, pp. 1, 2, 12, and 17). A wetland exists along the north shore of Kellogg Island (Ref. 3; and Ref. 20).

4.1.2.1 LIKELIHOOD OF RELEASE

4.1.2.1.1 Observed Release

Direct Observation

An observed release by direct observation is not being scored.

Chemical Analysis

- Basis for Chemical Analysis

Observed releases by chemical analysis are documented in the Duwamish River between RK 2.5 and 10.8 (see Section 2.2). The in case of PCBs, it should be noted that these compounds are not naturally occurring (Ref. 31, p. 1). For this reason, the background level can be considered to be 0.

- Attribution

Sediments in the Duwamish Waterway are contaminated with metals, SVOCs, PCBs, and organotins from RK 2.5 to 10.8 (see Section 2.2).

Much of the upland areas adjacent to the Duwamish Waterway are heavily industrialized (Ref. 4, p. 8). Property owners for land adjacent to the waterway between RK 2.5 and 10.8 are provided in Reference 4 pages 990 through 995. Over 100 outfalls exist along the Duwamish Waterway (Ref. 7, pp. 20, 43, 44, and 45).

As demonstrated in Section 2.2 of this Documentation Record, three separate investigations have documented observed releases to surface sediments in the Duwamish River between RK 2.5 and 10.8: the 1999 SI of the Lower Duwamish River conducted by Roy F. Weston for the EPA, the 1997 Phase I Site Characterization conducted by the Boeing Company, and the 1997 Duwamish Waterway Sediment Characterization Study conducted by NOAA (Ref. 4; Ref. 7, and Ref. 8). In addition to collecting surface sediments, 35 subsurface sediment samples (including one duplicate sample) were collected from 17 stations in the Duwamish River between RK 2.5 and RK 10.8 during the SI conducted for the EPA (Ref. 4, pp. 12 and 13). These subsurface samples indicate that sediment contamination in the Duwamish River between RK 2.5 and 10.8 may extend significantly deeper than the 10 centimeter depth used in Section 2.4.2.1.3 of this Documentation Record to determine the volume of the contaminated sediment source. Information to support these potential additional observed releases is provided as follows:

> The subsurface samples were co-located with selected surface sediment samples (Ref. 4, p. 12). At each selected station, subsurface samples were collected at 0 to 0.6 meters (i.e., 0 to 2 feet) and at 0.6 to 1.2 meter (i.e., 2 to 4 feet) using a gravity corer with a stainless steel barrel (Ref. 4, pp. 12 and 13). Sediment from each core was extruded onto a decontaminated stainless steel tray, sample material then was spooned into a stainless steel bowls for homogenization (Ref. 4, p. 14). Homogenized samples were placed into precleaned, labeled sample jars and stored on ice until shipment (Ref. 4, p. 14). Applied sample analytical methods were the same as for surface sediment samples (Ref. 4, p. 14; also see Section 2.2). Since background subsurface sample locations were not identified in the SI, three upriver sample stations were selected as background locations for use in determining observed releases (stations DR246, DR269, and DR284). The highest concentration per analyte of these stations was used as the background concentration when determining observed releases. Several stations contained observed releases of BNAs, inorganics, and organotins at depths up to 4 feet (see Table 11 below).
>
> Selected analytes meeting observed release criteria are presented in Table 11 (Ref. 1, Section 2.3). Not all analytes meeting observed release criteria are presented. Blank cells in this table are for those analytes that were not detected above their respective detection limits or were not detected at concentrations meeting observed release criteria. The following data qualifiers apply to this table:
>
> J - The analyte was positively identified and detected; however, the concentration is an estimated value because the result is less than the quantitation limit or quality control criteria were not met (Ref. 4, p. 379).
>
> L - EPA data qualifier indicating a low bias (Ref. 4, p. 379; Ref. 24).
>
> T - When present in data qualifier, indicates value was assumed from other constituents by software. Result was not present in original laboratory reports (Ref. 4, p. 379; Ref. 22; Ref. 24).
>
> U - The analyte was not detected at the given concentration limit. (Ref. 4, p. 379)

Further, the King County Department of Natural Resources Wastewater Treatment Division and Water and Land Resources Division performed a water quality assessment in 1997 (Ref. 17, pp. 15, 16). King County performed the CSO Water Quality Assessment for the Duwamish River and Elliott Bay to better understand the risk to aquatic life, wildlife, and people who use the resources of the estuary (Ref. 17, p. 12). King County concluded that clear

evidence of potential risks to aquatic life, wildlife, and people exists under the baseline conditions of the estuary (Ref. 17, p. 45). Seven City of Seattle or King County Combined Sewage Outfalls exist between RK 2.5 and 10.5 (Ref. 17, pp. 29 and 58). These outfalls are the Norfolk Street outfall, the 8th Avenue outfall, the West Michigan outfall, the Michigan Street outfall, the Terminal 115 outfall, the Brandon Street outfall, and the Duwamish outfall (also called the Hanford at Rainier outfall) (Ref. 17, p. 58). Combined these outfalls discharge 318 million gallons of raw untreated sewage annually to this river segment (Ref. 17, pp. 29 and 30).

Table 11

POTENTIAL OBSERVED RELEASE IN SUBSURFACE SEDIMENT SAMPLES

STATION NO. EPA SAMPLE NO.	SD-DR246-0000A 98394017	SD-DR269-0000A 98394025	SD-DR284-0000A 98394019	Highest of	SD-DR008-0000A 98394014	SD-DR021-0000A 98394012	SD-DR025-0000A 98394010	SD-DR044-0000A 98394023	SD-DR054-0000A 98394008	SD-DR068-0000A 98394016
	Background			Backgrounds						
	0 to 2 feet	0 to 2 feet	0 to 2 feet	0 to 2 feet	0 to 2 feet	0 to 2 feet	0 to 2 feet	0 to 2 feet	0 to 2 feet	0 to 2 feet
Page Number in Ref. 4	915, 941, 942, 954, 961	915, 941, 942, 954	918, 945, 946, 955, 961		903, 925, 926, 950, 958	903, 926, 950, 958	927, 930, 951, 959	906, 930, 951, 966	929, 930, 951, 959	906, 930, 951, 966
BNA (ug/kg)										
Anthracene	20	20 U	20 U	20	360	140	110		180	480
Benz(a)anthracene	120	80	110	120	1200				730	
Benzo(a)pyrene	160	80	150	160	1200				830	
Benzo(b)fluoranthene	180	90	160	180	1400				850	
Benzo(k)fluoranthene	160	80	150	160	1100				640	
Bis(2-ethylhexyl) Phthalate	340	120	370	370	6900 JL				1200	
Chrysene	180	120	160	180	1400				920	
Dibenz(a,h)anthracene	30	20 U	30	30	150				140	
Fluoranthene	320	220	330	330	2400				1800	
Fluorene	20 U	20 U	20 U	20 U	170	40	40	20	70	160
Indeno(1,2,3-cd)pyrene	140	70	120	140	630				510	
Phenanthrene	110	100	130	130	1400				630	700
Pyrene	310	190	310	310	3800	1300	1100		1700	980
INORGANIC (mg/kg)										
Arsenic	12	6	7	12					283	44
Cadmium	0.3	0.22	0.2 U	0.3	2.5	1.1		0.94	1.1	
Copper	56	30	41	56	192				802	
Mercury	0.17	0.1 JQ (0.2 U)	0.1	0.135	0.92					
ORGANOTINS (ug/kg)										
Di-n-butyltin	7		18	18					250	
Tri-n-butyltin	8		21	21	130	280	130		2500	100
PEST/PCB (ug/kg)										
Total PCB	97 T	40 UT	37 T	97 T	757 T	528 T	1154 T			2579 T

Table 11

POTENTIAL OBSERVED RELEASE IN SUBSURFACE SOIL SAMPLES

	Highest of	SD-DR112-0000A 98394002	SD-DR137-0000A-CC 98394027	SD-DR206-0000A 98394021	SD-DR220-0000A 98394031	SD-DR246-0020 98394018	SD-DR269-0020 98394026	SD-DR284-0020 98394020	Highest of	SD-DR008-0020 98394015	SD-DR021-0020 98394013
	Backgrounds					Background			Backgrounds		
	0 to 2 feet	0 to 2 feet	0 to 2 feet	0 to 2 feet	0 to 2 feet	2 to 4 feet	2 to 4 feet	2 to 4 feet	2 to 4 feet	2 to 4 feet	2 to 4 feet
Page Number in Ref. 4		934	909	912, 938	912	915, 941, 942, 954, 961	918, 945, 946, 955	918, 945, 946, 955, 962		903, 925, 926, 950, 958	903, 925, 926, 950
BNA (ug/kg)											
Anthracene	20	120		40		20	20 U	20	20	400	200
Benz(a)anthracene	120					120	90	110	120	430	570
Benzo(a)pyrene	160					140	70	130	140	430	530
Benzo(b)fluoranthene	180					180	70	140	180		660
Benzo(k)fluoranthene	160					140	70	130	140		460
Bis(2-ethylhexyl) Phthalate	370					650	140	650	650		2000
Chrysene	180					160	100	120	160	630	740
Dibenz(a,h)anthracene	30					30	20 U	30	30		
Fluoranthene	330					360	310	270	360	1100	1400
Fluorene	20 U	30				20 U	20 U	20 U	20 U	140	110
Indeno(1,2,3-cd)pyrene	140					100	60	120	120		
Phenanthrene	130					100	20	90	100		480
Pyrene	310					330	270	350	350	1500	1500
INORGANIC (mg/kg)											
Arsenic	12					20	5	8	20		
Cadmium	0.3					0.6	0.35	0.57	0.6	3	3.7
Copper	56					78	26	45	78		
Mercury	0.183					0.18			0.366		
ORGANOTINS (ug/kg)											
Di-n-butyltin	18					7		15	15	120	
Tri-n-butyltin	21					12		60	60		
PEST/PCB (ug/kg)											
Total PCB	97 T		469 T	1250 T	832 T	210 T	40 UT	108 T	210 T	1608 T	4043 T

Table 11

POTENTIAL OBSERVED RELEASE IN SUBSURFACE SOIL SAMPLES

	Highest of Backgrounds	SD-DR025-0020 98394011	SD-DR044-0020 98394024	SD-DR054-0020 98394009	SD-DR-112-0020 98394003	SD-DR137-0020-CC 98394028
	2 to 4 feet	2 to 4 feet	2 to 4 feet	2 to 4 feet	2 to 4 feet	2 to 4 feet
Page Number in Ref. 4		903, 925, 926	906	906, 929, 930, 951, 959	934, 960	912
BNA (ug/kg)						
Anthracene	20	80		430	90	
Benz(a)anthracene	120			1500		
Benzo(a)pyrene	140			1400		
Benzo(b)fluoranthene	180			1500		
Benzo(k)fluoranthene	140			990		
Bis(2-ethylhexyl) Phthalate	650					
Chrysene	160			1700		
Dibenz(a,h)anthracene	30			220		
Fluoranthene	360			3400		
Fluorene	20 U	40		150	20	
Indeno(1,2,3-cd)pyrene	120			850		
Phenanthrene	100			1500		
Pyrene	350			2800		
INORGANIC (mg/kg)						
Arsenic	20			622		
Cadmium	0.6					
Copper	78			720		
Mercury	0.366			1.44		
ORGANOTINS (ug/kg)						
Di-n-butyltin	15			220	57	
Tri-n-butyltin	60			2100		
PEST/PCB (ug/kg)						
Total PCB	210 T	1154 T	1932 T	753 T		730 T

- Hazardous Substances Released

The substances found in the observed releases by chemical analysis to the Duwamish River are Arsenic, Anthracene, Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Bis(2-ethylhexyl) Phthalate, Cadmium, Chromium, Chrysene, Copper, Dibenzo(a,h)anthracene, Di-n-butyltin, Fluoranthene, Fluorene, Indeno(1,2,3-cd)pyrene, Mercury, Nickel, PCBs, Phenanthrene, Pyrene, Tri-n-butyltin.

==========

Observed Release Factor Value: 550

4.1.3.2 WASTE CHARACTERISTICS

4.1.3.2.1 Toxicity/Persistence/Bioaccumulation

Table 12 below provides Human Food Chain Threat Waste Characteristics Factor Values for a partial list of those analytes present at observed release concentrations in the contaminated sediment source (see Section 2.2).

Table 12

HUMAN FOOD CHAIN THREAT WASTE CHARACTERISTICS FACTOR VALUE

Hazardous Substance	Source	Toxicity Factor Value	Persistence Factor Value[a]	Bioaccumulation Factor Value[b]	Toxicity/ Persistence/ Bioaccumulation Value (Table 4-16)	Reference
Anthracene	1	10	1	5,000	5×10^4	Ref. 2, p. B-2
Arsenic	1	10,000	1	500	5×10^6	Ref. 2, p. B-2
Benz(a)anthracene	1	1,000	1	50,000	5×10^7	Ref. 2, p. B-2
Benzo(a)pyrene	1	10,000	1	50,000	5×10^8	Ref. 2, p. B-2
Benzo(b)fluoranthene	1	1,000	1	50,000	5×10^7	Ref. 2, p. B-3
Benzo(k)fluoranthene	1	100	1	50,000	5×10^6	Ref. 2, p. B-3
Bis(2-ethylhexyl)Phthalate	1	100	1	50,000	5×10^6	Ref. 2, p. B-3
Cadmium	1	10,000	1	5,000	5×10^7	Ref. 2, p. B-4
Chromium	1	10,000	1	500	5×10^6	Ref. 2, p. B-5
Chrysene	1	10	1	500	5,000	Ref. 2, p. B-5
Copper	1	—	1	50,000	---	Ref. 2, p. B-6
Dibenz(a,h)anthracene	1	10,000	1	50,000	5×10^8	Ref. 2, p. B-7
Fluoranthene	1	100	1	5,000	5×10^5	Ref. 2, p. B-10
Fluorene	1	100	1	5,000	5×10^5	Ref. 2, p. B-10
Indeno(1,2,3-cd)pyrene	1	1,000	1	50,000	5×10^7	Ref. 2, p. B-12
Mercury	1	10,000	0.4	50,000	2×10^8	Ref. 2, p. B-13
Nickel	1	10,000	1	500	5×10^6	Ref. 2, p. B-14
PCBs	1	10,000	1	50,000	5×10^8	Ref. 2, p. B-16
Phenanthrene	1	—	1	50	---	Ref. 2, p. B-16
Pyrene	1	100	1	5,000	5×10^5	Ref. 2, p. B-17

a. River persistence values (Ref. 2).

b. Food Chain bioaccumulation values for fresh or salt water, whichever is higher (Ref. 1, p. 51617, Section 4.1.3.2.1.3; Ref. 2).

==========

Toxicity/Persistence/Bioaccumulation Factor Value: 5×10^8

SWOF/Food Chain-Hazardous Waste Quantity

4.1.3.2.2 Hazardous Waste Quantity

Source No.	Source Hazardous Waste Quantity Value (Section 2.4.2.1.5)	Is Source Hazardous Constituent Quantity Data Complete? (yes/no)
1. Contaminated Sediments[a]	434.256	No

a - See Section 2.2 of this document.

Hazardous waste quantity: 100

4.1.3.2.3 Waste Characteristics Factor Category Value

Toxicity/persistence factor value x hazardous waste quantity factor value: 1×10^6
$(10{,}000 \times 100) = 1 \times 10^6$, capped at 1×10^8)

(Toxicity/persistence x hazardous waste quantity) x food chain bioaccumulation factor value: 5×10^{10}
$(1 \times 10^{6)} \times (5 \times 10^4) = 5 \times 10^{10}$, capped at 1×10^{12})

==========

Hazardous Waste Quantity Factor Value: 100
Waste Characteristics Factor Category Value: 320
Ref. 1, p. 51592, Table 2-7

4.1.3.3 HUMAN FOOD CHAIN TARGETS

Level I concentrations for the Human Food Chain Threat are not being evaluated. The furthest upriver sample point used to document Level II concentrations is NOAA sample EIT02-04 (Ref. 4, p. 993). The furthest downriver samples used to document Level II concentrations are Weston samples DR001 and DR076 (Ref. 4, p. 990 and 993). The Duwamish River contains both fresh and salt water (Ref. 4, p. 7). Contamination of a watershed which contains a fishery has been established by the presence of hazardous substances with bioaccumulation factor values of 500 or greater in an observed release by chemical analysis (Ref. 1, Section 4.1.3.3).

Hazardous Substance	Bioaccumulation Potential Factor Value[a]	Location	Reference
Anthracene	5,000	See Section 2.2 of this document	See Section 2.2 of this document
Arsenic	500		
Benz(a)anthracene	50,000		
Benzo(a)pyrene	50,000		
Benzo(b)fluoranthene	50,000		
Benzo(k)fluoranthene	50,000		
Bis(2-ethylhexyl)Phthalate	50,000		
Cadmium	5,000		
Chromium	500		
Chrysene	500		
Copper	50,000		
Dibenz(a,h)anthracene	50,000		
Fluoranthene	5,000		
Fluorene	5,000		
Indeno(1,2,3-cd)pyrene	50,000		
Mercury	50,000		
Nickel	500		
PCBs	50,000		
Pyrene	5,000		

a. Higher of fresh and salt water values (Ref. 2).

4.1.3.3.1 Food Chain Individual

Species of fish present in the Duwamish River include chum, chinook, sockeye, pink, and coho salmon and steelhead trout (Ref. 11, p. 1). The river supports recreational, subsistence, and commercial fishing (Ref. 9; Ref. 11, p.1). Members of the Muckleshoot Indian Tribe fish the Lower Duwamish River for commercial, subsistence, and ceremonial purposes (Ref. 9). This area of the river is subject to Level II concentrations of hazardous substances having bioaccumulation potential factor values of 500 or greater (see Section 4.1.3.3).

==========

Food Chain Individual Factor Value: 45

4.1.3.3.2 Population

4.1.3.3.2.1 Level I Concentrations

Not scored.

4.1.3.3.2.2 Level II Concentrations

Between July and December 1994, 399 chinook salmon, 245 chum salmon, and 702 coho salmon were caught for sport in the Duwamish/Green River system (Ref. 13, p. 26). No information is provided on the weight of each fish, therefore, to be conservative, each fish is assumed to weigh one pound. In addition, during the summer of 1994 and the winter of 1994 through 1995, a total of 2,859 steelhead trout were caught for sport within the Duwamish/Green River (in King County) (Ref. 13, p. 54). The same assumption regarding fish weight is used to determine the number of pounds of steelhead trout caught. The total number of fish caught for sport within the 15-mile TDL is estimated to be 3,935 fish (399 chinook + 245 chum + 702 coho + 2,589 steelhead = 3,935 total). Assuming one pound per fish, the total pounds of fish is 3,935.

Also, in 1994, 3,246 chinook salmon, 4,528 chum salmon, 36,765 coho salmon, and 4 sockeye salmon were caught commercially from the Duwamish River (Ref. 14, p. 75). Assuming one pound per fish, the total pounds of fish caught commercially is 44,543.

Members of the Muckleshoot Indian Tribe engage in gill net fishing for various commercially important salmonoid species (Ref. 9). Tribal members fish primarily for chinook salmon, chum salmon, coho salmon, and steelhead trout (Ref. 9). The tribe fishes for commercial, subsistence, and ceremonial purposes (Ref. 9).

For scoring purposes it is assumed that greater than one pound of fish was caught from the area of Level II concentrations located between RK 2.5 and 10.8 on the Duwamish River.

Level I Concentrations Factor Value: 0
Level II Concentration Factor Value: 0.03

4.1.3.3.2.3 Potential Human Food Chain Contamination

The Suquamish Tribe currently utilizes the Duwamish River from the mouth of the river to the Spokane Street Bridge located at the southern end of Harbor Island for fishing (Ref. 3; Ref. 21, p. 1). This area of the river is recognized by the Treaty of Point Elliott as a usual and accustomed area of Suquamish ancestors for hunting and fishing (Ref. 21, p. 1). Since fish catch data for the Suquamish Tribe are not available, it is estimated that at least one pound of fish is harvested annually from this area for subsistence purposes.

Stream flow for most of the Duwamish River is regulated by the Howard-Hanson dam upstream of the junction of the Green and Black Rivers (Ref. 4, p. 7). The USACE has limited peak discharges to 12,000 cubic feet per second (cfs) at Tukwila and minimum flows to as low as 200 cfs, with an average flow of 1,500 to 1,800 cfs (Ref. 4, p. 7).

The potential targets value for the Human Food Chain Threat is calculated as follows (Ref. 1, pp. 51613 and 51621):

$$(0.03 \times 0.001) / 10 = 0.000003$$

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Potential Human Food Chain Contamination Factor Value: 0.000003

4.1.4.2 WASTE CHARACTERISTICS

4.1.4.2.1 Ecosystem Toxicity/Persistence/Bioaccumulation

Table 13 below provides Environmental Threat Waste Characteristics Factor Values for a partial list of those analytes attributable to Source 1.

Table 13

ENVIRONMENTAL THREAT WASTE CHARACTERISTICS FACTOR VALUES

Hazardous Substance	Sources	Eco-system Toxicity Factor Value[a]	Persistence Factor Value[b]	Bioaccu-mulation Factor Value[c]	Ecosystem Toxicity/ Persistence/ Bioaccum-ulation Value (Table 4-16)	Reference
Anthracene	1	10,000	1	5,000	5×10^7	Ref. 2, p. B-2
Arsenic	1	100	1	500	50,000	Ref. 2, p. B-2
Benz(a)anthracene	1	10,000	1	50,000	5×10^8	Ref. 2, p. B-2
Benzo(a)pyrene	1	10,000	1	50,000	5×10^8	Ref. 2, p. B-2
Benzo(b)fluoranthene	1	---	1	50,000	---	Ref. 2, p. B-3
Benzo(k)fluoranthene	1	---	1	50,000	---	Ref. 2, p. B-3
Bis(2-ethylhexyl)Phthalate	1	1,000	1	50,000	5×10^7	Ref. 2, p. B-3
Cadmium	1	1,000	1	5,000	5×10^6	Ref. 2, p. B-4
Chromium	1	100	1	500	50,000	Ref. 2, p. B-5
Chrysene	1	1,000	1	5,000	5×10^6	Ref. 2, p. B-5
Copper	1	100	1	50,000	5×10^6	Ref. 2, p. B-6
Dibenz(a,h)anthracene	1	---	1	50,000	---	Ref. 2, p. B-7
Fluoranthene	1	10,000	1	5,000	5×10^7	Ref. 2, p. B-10
Fluorene	1	1,000	1	5,000	5×10^6	Ref. 2, p. B-10
Indeno(1,2,3-cd)pyrene	1	---	1	50,000	---	Ref. 2, p. B-12
Mercury	1	10,000	0.4	50,000	2×10^8	Ref. 2, p. B-13
Nickel	1	1,000	1	500	5×10^5	Ref. 2, p. B-14
PCBs	1	10,000	1	50,000	5×10^8	Ref. 2, p. B-16
Phenanthrene	1	1,000	1	5,000	5×10^6	Ref. 2, p. B-16
Pyrene	1	10,000	1	5,000	5×10^7	Ref. 2, p. B-17

a. Higher of fresh or salt water values (Ref. 1, p. 51621, Section 4.1.4.2.1.1; Ref. 2).
b. River persistence values (Ref. 2).
c. Higher of fresh or salt water values (Ref. 1, p. 51617, Section 4.1.3.2.1.3; Ref. 2)

==========

Ecosystem Toxicity/Persistence/Bioaccumulation Factor Value: 5×10^8

4.1.3.2.2 Hazardous Waste Quantity

Source No.	Source Hazardous Waste Quantity Value (Section 2.4.2.1.5)	Is Source Hazardous Constituent Quantity Data Complete? (yes/no)
1. Contaminated Sediment[a]	434.256	No

a - See Section 2.2 of this document.

Hazardous waste quantity: 100

4.1.3.2.3 Waste Characteristics Factor Category Value

Ecosystem toxicity/persistence factor value x hazardous waste quantity factor value: 1×10^6

$$10{,}000 \times 100 = 1 \times 10^6, \text{ capped at } 1 \times 10^8$$

(Ecosystem toxicity/persistence factor value x hazardous waste quantity factor value) x environmental bioaccumulation factor value: 5×10^{10}

$$(1 \times 10^6 \times 50{,}000 = 5 \times 10^{10}, \text{ capped at } 1 \times 10^{12})$$

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Hazardous Waste Quantity Factor Value: 100
Waste Characteristics Factor Category Value: 320
Ref. 1, Section 2.4.2.2, Table 2-7

4.1.4.3 ENVIRONMENTAL THREAT - TARGETS

Level I concentrations for the Environmental Threat are not being evaluated. The furthest upriver sample point used to document Level II concentrations is NOAA sample EIT02-04 (Ref. 4, p. 993). The furthest downriver samples used to document Level II concentrations are Weston samples DR001 and DR076 (Ref. 4, p. 990 and 993). The Duwamish River contains both fresh and salt water (Ref. 4, p. 7).

4.1.4.3.1 Sensitive Environments

4.1.4.3.1.1 Level I Concentrations

Sensitive Environments

Not evaluated.

Wetlands

Not evaluated.

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Level I Concentrations Factor Value: 0

4.1.4.3.1.2 Level II Concentrations

Sensitive Environments

Puget Sound Chinook salmon are federally listed as threatened and use the Lower Duwamish River as habitat during a critical stage of their migration (Ref. 26; Ref. 28). The federal candidate species, Coho salmon, also occurs in the Lower Duwamish River (Ref. 28). These salmon use portions of the Duwamish River within the zone of Level II concentrations (Ref. 26).

Sensitive Environment	Location	Reference	Sensitive Environment Value Ref. 1, Table 4-23
Habitat known to be used by the Federally designated threatened species: Puget Sound Chinook salmon	Duwamish River	Ref. 26	75
Migratory pathway critical for the maintenance of anadromous fish species: Puget Sound Chinook salmon	Duwamish River	Ref. 28	75
Habitat known to be used by the Federally candidate species: Puget Sound Coho salmon	Duwamish River	Ref. 28	50

Sum of Sensitive Environment Value: 200

Wetlands

One tenth of a mile of estuarine intertidal emergent regularly flooded wetland has been identified along the zone of Level II concentrations in the Duwamish River on the north shore of Kellogg Island (Ref. 3; Ref. 20).

Sum of sensitive environment value + wetland value:

(200 + 25) = 225

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Level II Concentrations Factor Value: 225

4.1.4.3.1.3 Potential Contamination

Sensitive Environments

Nesting territory for the Bald Eagle, a federally designated threatened species is present in the west passage of the Duwamish River from the mouth of this passage to approximately river mile 0.9 (Ref. 12, pp. 1, 2, 12, and 17). A sensitive environments value of 75 is assigned for this species (Ref. 1, Table 4-23).

Wetlands

Not evaluated.

The potential targets value for the Environmental Threat is calculated as follows:

$$[(0 + 75) \times 0.001] / 10 = 0.0075$$

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Potential Contamination Factor Value: 0.0075